THE

ELECTRICAL REVIEW.

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THE

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NOW READY.

H. ALABASTER, GATEHOUSE & CO.

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TRANSPORTATION.

IN his address to the Society of Engineers, Mr. W. Beaumont made a statement pregnant with meaning. Here is part of it:—"We are using old machines, of which two are required to do the work of one new one, and we go on driving them, and the shafting for them, year after year, making very small instead of larger profits, and thus investing what profits we do make in things one-tenth as pregnant with dividends as investment in the proper plant for the works that made them would be." This statement is expanded in various ways—mill owners, for example, paying double for coal, because an engine and boiler must not be thrown away for no better reason than that they will run another 20 years, and men are constantly refusing to renew plant that will return a 10 per cent. saving, though they will invest money as savings at 3 per cent. Confining his remarks in a narrow channel, Mr. Beaumont referred more particularly to the millions thrown away annually for lack of roads and means of transport.

The importance of transport is evident, when it is remembered that our railways have cost over a thousand millions sterling. Transportation, indeed, is a factor in the value of so many material things, which, indeed, frequently have no value except when far removed from their place of origin, as, for example, coal. To-day it often costs more to send goods from place to place by rail than it did by horses on the common roads, and is it not a disgrace that the Post Office finds it cheaper to use horse vans on the road than to submit to railroad extortion for parcel carrying.

It costs 9s. 6d. per ton to send goods the 35 miles between Manchester and Liverpool by rail. It can be done by horse traction for 8s. 6d., and by road traction engines for 2s. 11d. to 3s. 6d. per ton. But the roads would be ruined by such carriage of 15,000 tons weekly, and this is only one instance of the need of better facilities. But there are wanted more transportation facilities in other places, and the time has now come for the engineer to improve his own works. Improved roads would admit of better vehicles, and would give rise to new industries in motor cars. Railroads sprang up from faulty roads. To-day roads are no better than some of those made by the Romans, and we admit this by laying metal rails and admit tramcars upon these to the detriment of every other form of street vehicle. Two horses can haul on a tramway 42 passengers against 26 in an omnibus, and so we allow our roads to be spoiled by grooved rails We refuse to make a good road all over, but convert our roads into poorly managed railroads.

All possible underground and overhead means of travel in London are overcrowded, and it is now a first necessity to improve the ordinary roads. To do this, the light vehicles must evidently accommodate themselves to the roads that will stand the wear of the heavier vehicles of, say, 2 tons per axle. This is easier done than to make a road to stand the wear and tear of horses. The need is for better and more durable surface and substratum, and better methods of main-

tenance and repair, and a general minimising of the gradients. Axle load can be dealt with by using more wheels, so that tyres of yielding but good wearing material may be employed in place of steel edge runners. We need not dilate on the folly of constantly tearing up roads to get at pipes and other things. The subway, as in Northumberland or Shaftesbury Avenues, is too obvious an economy to require any emphasis. Macadam roads are not made as they should be, nor attended after making as they ought to be, to keep them up to the mark while the new surface is consolidating.

Road metal ought to be much more finely broken. Referring to the great economy of man's time effected by railroads, as compared with the old coach system, it is said there are still 106,000 horses at work in London alone. They are pounding the streets to pieces, and doing double the destruction of iron-shod wheels, and they are also the cause of much traffic of food, &c., some 20,000 tons a week in fodder and food alone, while an army of scavengers with carts and other horses are required to clean up after them.

At least one-third the total vehicular space is represented by the horse. Abolish the horse, and the streets at once become 50 per cent. larger, and many street blocks would be avoided. This is quite apart from the loss due to stoppage of streets for repairs due to the pounding of hoofs. From one to two hundred millions sterling spent on our roads would be an economy. The resistance of a railway per ton is 6 to 12 lbs.; for a tramway, 15 to 40 lbs.; on a good road surface of best quality, 25 to 30 lbs.; on good macadam, 38 to 60 lbs., and so on to 140 lbs. for gravel. Thus, a horse's efficiency on asphalte is double what it is on macadam, and so on. Similarly the resistance due to gradients is enormous, and jumps from, say, 45 lbs. on the level for good macadam, to 157 lbs. for a slope of 1 in 20. Yet many gradients are 1 in 8, or 1 in 10, which latter would demand 269 lbs. per ton. It is these gradients which make a motor vehicle demand a 16 H.P. motor, where one of 3 to 4 H.P. would suffice.

There are 1,200,000 draught horses in the country. Assume only 500,000, however, at £30 a year each for food and lodging, at least a third might be dispensed with, and save the country £5,100,000 a year, or, capitalised, £170,000,000 at 3 per cent., which is, therefore, what might be spent on the roads at a low estimate to save one-third of the horses employed.

As regards tramway traction, Mr. Beaumont seemed to favour steam motors or gas, because at present the Serpollet cars of Paris, and the Blackpool gas cars only cost about 4½d. per car mile and electricity costs 6d. But he thinks no small tramway can succeed properly. Tramways ought to be worked by powerful companies, as is now being done for electrical traction, when, perhaps, steam and gas systems may succeed.

We fancy Mr. Beaumont in this has not taken into effect the rapid acceleration which electricity makes possible and the economy of time thus secured. The general trend of his remarks may be summed up as a call for better road surfaces, so that road motor vehicles could be used, and easier gradients. He might have added a special word of commendation of our early railroad engineers, who aimed at directness and as close an approximation to levelness and no gradients as possible. Few know what is being saved by George Stephenson's determination to make the locomotive a success. He never over-rated its powers, but built huge embankments and made heavy cuttings so that it might have a level road.

We do not know if it is wise for an engineer to neglect finance altogether. It may save the labour of many horses to spend millions on the roads; but the man who has no horse would object to pay a sovereign for road tax, in order that his neighbour, who has horses, may save, say, £30 a year. There is clearly something to be urged against the abolition of the old toll gates, which, at least, taxed users directly. Mr. Beaumont's paper is suggestive. It is a little unpractical, but presidential addresses are perhaps better when not too closely argued. The subject of good roads is a very wide one. From the socialist standpoint their improvement could be undertaken, for no doubt large expenditure would return good interest to the community at large. But socialism is not at present within the range of practical politics, simply for lack of the only single essential to success, to wit, absolute fair dealing. With no horses, and with all tyres of suitable width for their loading, and of soft material, there is an evident perfection of road surface to-day possible, which would have great durability, for there would be no grinding wear. Such roads would imply an immense motor car industry. Doubtless this was the thought underlying the address.

The Gale and the Wires.

In a recent issue of the *Globe* attention is once more drawn to the interruptions which have occurred to telegraphic communication caused by the late gale. The cause, says that highly scientific daily, "is perfectly well known, and has repeatedly been pointed out in this journal. It is neither more nor less than our foolish system of employing overhead telegraph wires. For this there is nothing whatever to be said, except that it is rather cheaper in first cost than laying them underground." . . . "Other countries have underground wires, why not Great Britain? Years ago, even Switzerland managed to organise such a system, and was charging half-a-franc for messages upon which we in England are still paying a shilling. There should be no difficulty in the way of laying the trunk wires underground in this country." Such effusions as the foregoing are so common in the daily press and indicate such accurate knowledge of governing factors, that no doubt the Postal authorities will be at last ashamed of themselves and will proceed to abolish the overhead system and substitute underground work, as it can be done at a trifling expense, and will solve the question of uninterrupted fast-speed telegraph working and long distance telephony. It is, perhaps, needless to say that the so-called Swiss system is a pure imagination of the writer in the *Globe*, and that the idea that an underground system capable of carrying the enormous traffic which passes over the immense network of wires of the United Kingdom could be laid without difficulty, that is at a small expense, is simply ridiculous, let alone the fact that long distance telephony through underground work is impossible with our present knowledge. No doubt, however, the writer in the *Globe* knows all about the mysteries of "K. R."

Board of Trade Electrical Standardising Laboratory.—We have received a copy of the Board of Trade table of fees for examination or testing of electrical instruments for the measurement of resistance current or electrical pressure.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A strong muster of central station men graced the last meeting of the Institution of Electrical Engineers on Thursday, March 24th, to hear what Mr. Hammond had to say as to "The Cost of Generation and Distribution of Electrical Energy." The proceedings were exceptionally interesting, inasmuch as the paper before the meeting was in the hands of the members, and the writer of the paper explained what was in it in an able discourse, lasting three-quarters of an hour. We all know Mr. Hammond to be one of the hardest workers in the profession, and were prepared for the clear and decisive character of his speeches. On Thursday evening he was at his best, and, from a few notes, gave all the leading points in his most voluminous printed paper in a telling fashion, which went down with the meeting as no reading could have done.

To briefly summarise Mr. Hammond's remarks is to index his paper, and it is worth while to do so under the circumstances. Firstly, he pointed out the difference between local authorities and companies, as regards the location of salaries and wages in the Board of Trade form of accounts; then he stated that these accounts have been systematically kept since 1890, and expressed the hope that the time will come when the Board of Trade will publish the figures sent in according to statute. The usual method of dealing with the quantity of electrical energy turned out is to take the costs of the unit delivered to the consumer, although some would prefer, as fairer, that the units should be taken as they leave the works.

The editor of a well-known contemporary has said that the reduction of cost of electrical energy is always to come. It may be replied that the cost to the consumer is even now one-third of what it was in the earliest days of public supply, while any such statement bearing on the actual cost of production can be easily refuted by perusal of the figures contained in the paper.

Mr. Crompton's paper of 1894 showed what had been and might be done, and further evidence of reduction in cost was given by such figures as have been obtained year after year by the Westminster, Manchester, and Leeds stations, proving conclusively that the tendency of costs is always to decrease. Ideal costs could be obtained by taking the lowest of the respective items as they now stand; while at Edinburgh, Leeds and Manchester, figures closely approaching Mr. Crompton's ideal figures have been obtained with much lower outputs than Mr. Crompton allowed.

Mr. Hammond then considered the factors that affect cost, such as:—

1. Output, the leading factor.
2. Load factor, the next important after output.
3. Reliability of plant, the general smooth running of things.
4. Engineer factor, the ability, assiduity and earnestness of the responsible engineer or engineers.
5. Efficiency of plant, as affecting consumption of fuel, &c.
6. Efficiency of distribution, as affecting outside losses, &c.
7. Cost of fuel, &c.

We have now an approach to the figure given by Mr. Crompton as a prophecy, that the cost in London would fall to 1·32d. per unit, and Mr. Hammond ventured to add that, when the output *does* reach 5,000,000 units, we shall see the cost as low as 0·75d. per unit.

Major-General Webber then opened the discussion by expressing his desire to say that all felt that there are individuals on this earth to whom we should like to be introduced, and that he was then introduced for the first time to one whom he had been very anxious to meet, "Chesterfield Junior." While he did not doubt that the statistics of this gentleman were quite as accurate as other statistics, still he thought that from the way they must be compiled they could not be of much use to the engineer as an engineer. For example, from the respective positions of various companies in the coal statistics in the paper it may be well argued that the order of merit shows completely how unreliable such figures are in forming an opinion. In short, that these figures to the engineer, however valuable they may be generally, are nothing more than suggestions; outside the gentlemen interested he thought no one could tell the reason for the particular order in which the various concerns fall. Further, it might be of use, however, if tables were prepared bringing down the figures to a uniformity by giving the calorific value, &c. Losses unaccounted for might also be classified, as by a heavy expenditure on copper, losses by resistance are minimised; some systems embody storage, and so many points have to be considered, that if everything were taken into account the results might come out in some other way to that at first obvious.

Mr. Crompton felt obliged to Mr. Hammond for his paper, as he had at recurring periods of three years written papers on this subject, and in this case Mr. Hammond had done the work for him. Anyone who knew the trouble and labour involved in the preparation of such a paper must be wild to hear it spoken of—as had been the case—as a compilation. As regarded the paper itself, he did not wish to say anything on points on which others might speak, but from his special experience he would emphasise the importance of investigating details of costs and losses, and Mr. H. W. Miller, nearly 10 years ago, adopted such analysis, being thus almost the father of weekly returns. The very great advantage of the Board of Trade returns was the arousing of the sporting instinct of the race, where central station supply was concerned. Prof. Kennedy, and many others, frequently suggested improvements in the method of displaying and arriving at the figures given in *Lightning's* tables and similar summaries of the technical press, that the race for honours might be a fairer one, bringing out as far as possible the merit of the engineer, but where conditions differ widely, it is very difficult to do so. He knew the difficulty, as in his last paper he attempted, by a knowledge of the calorific values of different coals, to arrive at a fair comparison, but was told that the resulting figures were his figures, and he admitted this. It was extremely difficult to bring things to a level. Engineers do not often have control of the management, and they cannot control the local authorities. Local taxation sometimes is very heavy, and may even now reach a value of two-thirds of the cost of coal; as times goes on, the two curves will cross one another.

After some remarks on the coal bill and its effect on the cost per unit, Mr. Crompton went on to say that a low coal bill is not of much credit to a station if extinctions frequently occur; that it is a suicidal policy to restrict the generation to a single station, and it is better to have two or more stations for a large supply. This is a little more expensive, and large London companies with multiple stations cannot be fairly compared with other systems, such as Brighton, worked from a single station. Quite recently there have been a good many smashes, and a point he attached importance to was the unreliability of directly generating at very high volts, as, if steam pipes break, bang go your coils. Such machines will not stand large quantities of escaping steam with impunity.

He had proposed the word "load factor," but the present use of this term was not quite satisfactory, and although his present proposal was rather complicated, he thought it more useful; that is, to take the number of hours per year that the plant would have to run to give the actual output—not a difficult thing to calculate.

Then low costs are due to the men controlling works. It is most important to get the very best men, and he would wish some means could be found to give the real representative order of merit, so as to show who really are the best men. Continuous publication of results is developing a race of highly skilled organisers—men who must be well paid, and will not be obtained for the remuneration of a mere clerk.

Mr. Wordingham thought the labour of preparing the paper must have been enormous, and as an evidence of the care taken in working out the figures, Mr. Hammond, he noted, had not overlooked the fact that last year was leap year. He thought it rather a mistake to leave out of sight capital cost, and the charges due to this often amount to half the real costs of production. Load factor is, after this, the real thing affecting cost. Ideal costs may be rather misleading, as electricity supply may be combined with other work. Also, there is a danger of competition being carried too far, and everything being sacrificed to low figures. He then

referred to the low charges made at Manchester and Brighton, and urged the putting aside of a certain sum periodically to depreciation. He stated that he should personally be obliged to any contractor who would tell him actually the upper or largest size of unit actually to be obtained.

Prof. Forbes considered the curves of very great interest to all. After some general remarks on the desirability of limiting the use of curves and figures to the obtaining of facts and arguments which could, without error, be obtained from them, he pointed out that not only did the cost per unit fall with lapse of time from the start of a work, but also with output—which rose as time went on. Part of the reduction may be due to improvement in plant and methods, and part only to increased output.

Mr. Grimshaw explained a diagram he had prepared, showing that at the Eccleston Place works of the Westminster Company, he had got down to 4·75 lbs. of coal per unit with exceptionally good loads, and had reached 4 lbs. on a 3—11 p.m. shift in winter, and considered it improbable that very much lower figures would be reached for some time to come.

Prof. R. H. Smith thought that Mr. Hammond's estimate of reduction of cost with output was exaggerated, as workmen and managers would expect some increase in greater proportion than seemed to have been allowed. It is also always a question of incidence of interest and depreciation, against decrease of working cost on the other side, as by spending capital the working cost can be reduced.

At this stage the discussion was adjourned until next meeting.

ELECTRIC TOWBOAT IN A SEWER.*

The city of Worcester has a large sewer 18 feet wide and 13 feet high. The sewage of the city is treated chemically to render it fit to flow back into the Blackstone River, so that it is desirable to separate the storm water from the sewage to lessen the expense of the chemical treatment.

In order to accomplish this end a smaller sewer, 6 feet wide and 4,000 feet long, is being built inside the larger one, utilising the bottom and one of the sides of the sewer. A cofferdam is constructed to enable the other wall of the sewer to be built, and in order to deliver materials to the workmen an electric scow was rigged up, which has been found very satisfactory. Electricity is also used to light the sewer, to operate ventilating fans and to work electric pumps. All of the lighting and power are generated on the premises in a small building outside the sewer. About midway between the ends of the sewer a small dock has been constructed and the materials are delivered to it by an incline through a hole made in the top of one wall.

The towboat is a catamaran 22 feet long and 5 feet wide. Each of the small boats is 18 inches wide. In the middle of the catamaran is a small paddle wheel box which is to prevent splashing. This is driven by means of sprocket wheels and chains which are connected with an electric motor of 2½ horse-power. At the stern end is a rudder and controller, so that one man can operate both. Only one electric boat is used. It tows six scows, which have already handled 12,000 bricks, 50 barrels of cement and 100 barrels of sand daily. The double trolley system is used, the wires being hung from insulated brackets secured to the top of the arch in such a way that a trolley can be run on it. A scow is also fitted with a centrifugal pump which is used for pumping out the cofferdam, and it is driven by another motor of 14 horse-power. The application of the electric towage to sewer construction is novel, and the results obtained are most satisfactory.

The electric scow was designed by Mr. Harrison P. Eddy, Superintendent of Sewers, Worcester, Mass. Mr. Robert N. Kendall is the assistant in charge of the electrical work.

* *Scientific American.*

CONDITIONS OF CONTRACTS.

We have several times lately referred to the onerous and often unfair clauses of specifications which are enforced against contractors. As we write, we have before us several specifications, from which we propose to select a few samples of clauses which, in our opinion, cannot be fairly upheld.

For example, in a clause for testing materials, the contractor is required to supply, free of charge, all labour and testing apparatus, and the tests are to be made when and how the engineer may direct. Without doubt the engineer ought to have the power to specify tests, but why should the contractor be exposed to the cost of finding apparatus and labour to his own possible undoing. This clause does not appear satisfactory, because it is not sufficiently rigid, and presents a difficulty in estimating the price to be put in. A personal knowledge of the engineer and his testing idiosyncrasies might be sufficient to give a great advantage to one contractor over another, while the lack of such knowledge might put a contractor to an unexpectedly large expense. Tests should, therefore, be standardised where possible, and an aggrieved contractor should have an appeal to an unbiased outside authority.

Under the head of power to vary works we consider it eminently unfair that a contractor should be paid under schedule of prices only. What of materials rendered useless by the variation? Is the contractor to have no recompense for his time and trouble, but simply be paid perhaps a few pounds on a schedule rate which was priced for amounts 50 times larger than those involved in the alteration.

In public work the item of watching may prove serious, so also may the contractors' responsibility for accidents even when caused by following the engineer's instructions. An engineer demands something to be done, perhaps, to expedite work; the contractor is obliging and does not wish to object, or, if he do object, he may become liable to penalties at the sole option of the engineer, and then when an accident happens the contractor bears it all.

There is a clause as to daywork in one specification before us, to the effect that daywork must be sent in not later than the next day after the time was made. There is nothing unfair in this, and contractors ought to be very stringent on this point. We have known where a contractor was easy and was anxious to help on work, and neglected to divide

off the daywork from contract work and lost the whole of it amounting to over 10 per cent. of the whole work. Contractors find a difficulty with workmen. It is almost impossible to get the average working engineer to keep time separate on day and contract jobs. Workmen are hopelessly unintelligent in this respect, and if pressed to keep the time feel aggrieved as though they were being doubted. We have seen a good tradesman fairly dance with excitement when pressed to keep a time record on jobs, and end up by asking for his—money, and departing. Engineers who are intelligent and see no difficulty in keeping time separate, fail to appreciate the position of a contractor who has workmen to deal with. Take that honest man, the bricklayer, who shatters his health in disposing of a couple of hundred bricks daily. When these men are requested to hurry a job along down go their trowels and off they troop to the pay office, and between slow work and no work the contractor does not know how to meet the demands of the engineer for more rapid progress. *Apropos* of the recent *fiasco* at Bradford, there is a good clause before us, to the effect that no alternative scheme shall receive consideration. At Bradford, we presume, this was not a clause, and an alternative scheme was considered, and it ought not to have been in the absence of a special proviso to that effect. Alternative schemes either should be invited or should be specially barred out.

In another specification we find a particular type of boiler is demanded, and its evaporation per hour is laid down when using steam coal hand fired, both in the gross and per pound of coal. Now this is open to many objections. The engineer ought to fix the size of the boiler if he can fix its maker. One contractor may supply a boiler that is too small; he may make an error. True, he could be made to put in another boiler to do the specified duty, but this is not the object of employing an engineer. It is the engineer's duty to avoid disputes, not to lay traps for mere contractors.

The same engineer who specified as above, also specified for a gas engine to run at an absolutely steady speed of so many revolutions per minute. He specified a make of engine which governs by cut-out explosions. How then could he expect to get a steady speed of 160 or 190 revolutions when the cut-out is effected by speed variation. "Absolutely steady" are the words used, not sensibly steady; but further on it is provided that the speed variation shall not exceed a given allowance. Why first have asked for an impossibility, and then have toned down. These tonings down are apt to be extended by contractors perhaps too liberally to other clauses.

In yet another specification the contractor is under penalty to complete at a date given, and the engineer has the right to delay delivery or erection without extra payment, and the contractor's only benefit is to be an extension of time at the option of the engineer.

There are all sorts of claims which may be enforced against the contractor even to delaying work, and yet enforcing the penalty for non-completion by given date. We should doubt whether, under such circumstances, a court of law would allow a penalty to be enforced, but here again is that loophole for dispute and legal action which an engineer should avoid, which he is paid to avoid in truth.

This is a point on which we would like to insist. It is all very well to treat contractors as so many mere money grubbers. Contractors have their retort upon engineers, many of whom are not free from the reproach of making little jobs into big ones for the extra commission thereon. But whether contractors are all that many specifications would seem to imply, or whether they are not, a specification is intended to be a document that shall obtain justice all round. At present the aim of some specifications seems to be to place the contractor in a position to bear the brunt of any possible mistake or oversight on the part of the engineer, so that the engineer's paymaster may not be called on to pay for such oversight or error. This is unfair to the contractor. Of course, in the long run, the cost of these things comes upon the customer, for the contractor adds for contingencies, or in other ways increases the amount of all his tenders to cover such items. At the same time if such clauses could be eliminated, and contractors could rely upon fair treatment, all work could be taken at narrower margins and really just specifications would carry weight and could be easier enforced.

In one specification only do we find a bonus for earlier completion as well as a penalty for late completion. This is fair, but it is not fair to delay work and allow nothing for delay. A contractor is not necessarily wealthy. He has provided for delivery of goods and often wants payment to meet his liabilities. If compelled to obtain an overdraft he has got to pay several per cent. for the accomodation, and his banker only then grants it if he is sure of the final money. The very delay in work may be weakness and may stop a contractor's overdraft. Power to delay work irresponsibly, especially where the contractor has hurried goods forward to avoid penalty, is grossly unfair. As an American writer pointed out lately, it demoralises the workshop to see push goods lying waiting delivery after proper date.

The very presence of unfair clauses emboldens the unfair contractor to encroach, for too harsh a document enlists sympathy with him, and as juries were wont to convict sheepstealers of manslaughter to save their lives, so will contractors escape just penalties if held liable to unjust punishments.

It is not only in commercial clauses that we find items that are difficult to consider. What, for example, are we to think of an engineer's demand for gas engines to secure the highest economy and the minimum speed variations, conditions inimical to each other, the one demanding a system of governing differing from that demanded by the other?

Why, too, should a contractor be made responsible for the efficiency of producer gas supplied to work his gas engines, and be compelled to bear the expense of proving the gas quality to be wrong? If there be a doubt as to producer gas, a holderful could be made and its quality ascertained, and the engine run upon this. Producer gas must be fairly bad if a gas engine cannot work with it. There might be a standard gas, one that should not contain less than, say, 30 per cent. of combustible.

In reading through many specifications for all manner of work, it occurs to us that it is to the credit of our engineers and contractors generally that matters go as smoothly as they do. But specifications are usually so outrageous, that when a contractor goes to see plans and read specifications, he pays little attention to the most objectionable clauses. We have seen an inexperienced man with no knowledge of these matters, when confronted with objectionable clauses, put on outrageously big sums to cover them, to his own undoing and the loss of profitable work. Of course, such a man ought not to see such specifications, but the question arises, Should such things to be? Is it not possible to secure good work with more rational and standard clauses? The trial is being made. Let us hope success may attend it.

THE EFFECTS OF TENSION AND QUALITY OF THE METAL UPON THE CHANGES IN LENGTH PRODUCED IN IRON WIRES BY MAGNETISATION.

Mr. Byron B. Brackett has recently published in the *Physical Review* (America), Vol. V., No. 5, an account of the results of a long series of experiments on the subject of the title, with special reference to the effects of tension upon the phenomena. The experiments have been carried out with great care, and values of the different quantities involved very completely recorded. Tests are reported on piano wire in its natural condition under two different stresses, 658 and 1,949; on annealed piano wire under three different stresses, 62, 699, and 1,949; and on soft iron wire under four different stresses, 48·3, 430, 752, and 1,720; stresses being in all cases measured in kg. per sq. cm. The diameter of the piano wire was 1·25 mm., and of the iron wire 1·31 mm. Round the vertical stretched wire as an axis were arranged three pieces of apparatus. The first attached to the wire at two points was an arrangement of levers carrying a tilting mirror for observing on a scale the changes in length of the wire. The movement observed on the scale

was 25,000 times the change in length of the wire. Round this was a cylindrical jacket of circulating water, designed to prevent, as far as possible, any change in the temperature of the wire by radiation from the magnetising coil; and outside this was the magnetising coil itself. Both these last pieces of apparatus were supported quite independently of the wire. The maintenance of a steady temperature was very important, as the largest magnetic effect observed in the series of experiments is about the same as would be caused by a change of ·3° C., and even with the water jacket the temperature changes are said to have been very inconvenient. For the details of the apparatus, which had been used by two previous observers, we may refer our readers to the original paper, and confine ourselves to the results obtained. The quantities observed or calculated at each stage of the magnetisation were the following:

1. The extension or contraction $\pm \frac{d\,L}{L} \times 10^7$, called E_T, when the magnetic force was applied, with B the magnetic induction, I_T the magnetisation, and H the magnetic force.

2. The same quantities with the magnetising current interrupted, viz, the residual extension, or contraction, $\pm \frac{d\,L}{L} \times 10^7$, called E_R, and I_R the residual magnetisation.

The course of taking the observations was as follows:—Starting with the wire demagnetised, a small magnetic force was applied and E_T and H noted. The magnetising current was stopped and E_R noted. A stronger current was applied in the same direction as before, and E_T and H again noted. The current was again stopped and E_R taken. This course was followed up to the highest magnetisations employed. Another series of observations was afterwards taken with increasing reversals, and a secondary coil in circuit with a ballistic galvanometer, to obtain the values of B corresponding to the values of H previously employed. I_T and I_R were calculated from the B H figures.

The numerical results are given in tables, and plotted in diagrams. The five sets of results obtained from the steel piano wire, hardened or annealed, and under different stresses, give curves of very similar character, and we reproduce one as an example. In every case the magnetisation under the magnetising current was raised to about 1,400, with a value

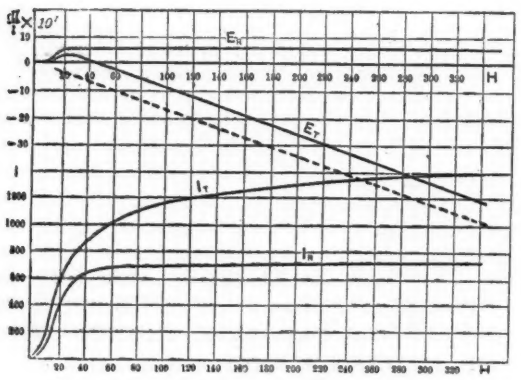


Fig. 1.—Annealed Piano Wire; tension 699.

of H about 340. The two curves giving the values of I_T and I_R, *i.e.*, of the intensity of magnetisation with the magnetising current, and after the current has been interrupted, are of the usual character, and call for no special comment; but those giving the values of the extension and contraction of the wire, drawn on a large scale, are of considerable interest. Comparing the curves (fig. 1) of I_T and E_T plotted to H, it is seen that no extension was observed till a considerable magnetisation was attained—E_T does not leave the zero line till $I_T = 9$. The extension soon attains a maximum when $E_T = 2{\cdot}84$, and $I_T = 81$, and then diminishes, quickly changing to a contraction. The curve of E_T then follows a descending straight line which shows no sign within the range of experiment of a minor limiting value.

Comparing the curves of I_R and E_R, also plotted to H, it is seen that E_R remains zero till a certain magnetisation is attained, but begins to have an appreciable value at a lower magnetisation than E_T, the curve leaving the zero line when $I_R = 26$. The value of E_R then increases to 5·4, when $I_R = 580$, and retains the same value through the rest of the experiment, although I_R continues to increase throughout very slowly after a value of 700. The author points out that the curve of E_T appears to represent the sum of two quantities, first, the curve of E_R, and second, the dotted straight line drawn in the diagram (added by us to the author's figure), and it is suggested that the change in length is the sum of two effects: an extension due to the magnetisation, represented by the curve E_R, and a contraction directly proportional to the magnetising force, or perhaps to its excess over a certain small amount. In considering this very interesting suggestion, it should be borne in mind that the maximum contraction observed in any of these experiments on piano wire only amounted to $\frac{1}{200000}$th part of the length. The experiments on these wires under different stresses

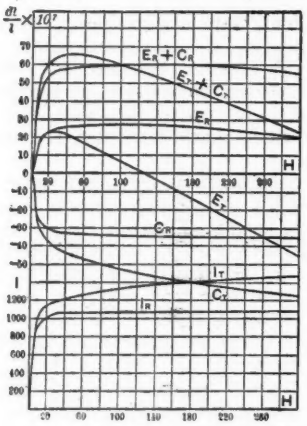


Fig. 2.—Soft Iron; tension 430.

showed that an increase in the stress has no effect on the position of the dotted line, but tends to bring the curve of E_R nearer to the zero line, and the point where it first reaches its maximum nearer to the origin.

The reduction of the experiments on iron wire is more elaborate, but the results are very similar. Acting on a

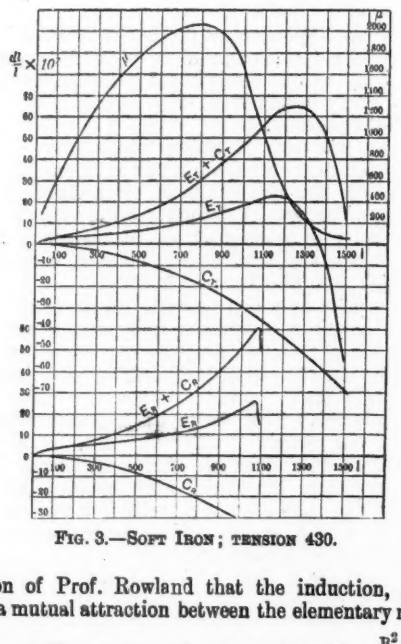


Fig. 3.—Soft Iron; tension 430.

suggestion of Prof. Rowland that the induction, B, must produce a mutual attraction between the elementary magnets, and consequently a compression proportional to $\frac{B^2}{8\pi}$ (or in the case of residual magnetisation to $2\pi I^2$), divided in each case by Young's modulus. The values of these compressions, called C_T and C_R respectively, are also plotted. The curves lettered $E_T + C_T$, and $E_R + C_R$, are drawn giving

what may be supposed to be the total extension due to the magnetisation, independent of the compression C_T or C_R.

Figs. 2 and 3 give the results of the investigations on iron wires under a tension of 430 kg. per cm. plotted for H and I respectively.

In fig. 3, the near equivalence of the curve E_T, to a combination of the curve E_R with a straight descending line, is well seen. The effect of increased tension in lowering the curve E_R without affecting the position of the descending line, was found to hold in iron as in piano steel.

Explanation of the Tables and the Notation used in the Tables and Plates.

H = the magnetising field.

$E_T = \frac{\text{change of length}}{\text{length}} \times 10^7$ while H is on.

$E_R = \frac{\text{change of length}}{\text{length}} \times 10^7$ after H is removed.

B = total induction or $4\pi I + H$.

I_T = magnetisation of specimen with H on.

I_R = magnetisation of specimen with H off.

$\mu = \frac{B}{H}$ = magnetic permeability.

$C_T = \frac{\text{change of length}}{\text{length}} \times 10^7$ that would be caused by a mechanical pressure $= \frac{B^2}{8\pi}$.

$C_R = \frac{\text{change of length}}{\text{length}} \times 10^7$ that would result from a mechanical pressure $\frac{(4\pi I_R)^2}{8\pi}$.

If these compressive forces actually exist, then the values of E_T and E_R computed from the observed changes are too small by C_T and C_R respectively, and

$E_T + C_T$ = the real $\frac{\text{change of length}}{\text{length}} \times 10^7$ with H on.

$E_R + C_R$ = the real $\frac{\text{change of length}}{\text{length}} 10^7$ with H off.

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.

The paper on the above subject, prepared by Mr. Hammond for the Institution of Electrical Engineers, and of which an abstract was read by him at the meeting on March 24th, is certainly one of the most valuable contributions of recent times, and should be specially appreciated by all those who desire to make themselves acquainted with the present position and future prospects of the supply industry on account of the great mass of statistics which has been collected and tabulated by the author.

In introducing his subject, Mr. Hammond explains how it is that the supply industry is obliged to furnish such detailed cost sheets, to prepare the annual statement of accounts in a prescribed form, and to publish and sell these statements to any applicant for not more than a shilling a copy. It certainly does seem remarkable that this obligation should have been accepted without a murmur when we know that no other trading concerns are under the same necessity, and that the majority of them would strongly object to publishing details of their costs of production; but it must not be forgotten that the conditions are somewhat special in that, with very few exceptions, there is no direct competition, and that a knowledge of the working costs of one concern can seldom be used to its detriment by a rival company anxious to engage in a war of cutting down prices. Whatever the reason may have been for the acceptance of this obligation, there is little doubt that the publication of these accounts has had a beneficial effect, and has fostered a healthy rivalry between managers and engineers of supply undertakings, each of whom has generally been anxious to go one better than his neighbour. There is a danger that this may be carried too far at the expense of the financial soundness of the undertaking, and that managers may have a tendency to charge certain items to capital account which more properly should be included in revenue account; but we believe that the Board of Trade is not by any means inclined to leave such matters entirely in the hands of the managers, and that this danger, if it exists, is therefore not an important one.

Attention is drawn to certain differences in the form of accounts prescribed for local authorities and for companies, and we quite agree with Mr. Hammond that it is desirable to procure uniformity as an aid to a useful comparison of the accounts of various undertakings. These differences are that the companies have to charge a proportion of the salaries of engineers to cost of generation and distribution, whereas the local authority charges the whole to management, and that provision is made in the companies' form for remuneration of directors and auditors and for depreciation. With regard to the salaries of engineers, it would certainly be more reasonable that the local authority should do as the company is obliged to do, and that in both cases a proportion of the salary of the managing engineer only should be charged to management; and as regards depreciation, a more uniform manner of dealing with this charge is desirable, although we do not see how this can be brought about by any change in the form of accounts.

Before dealing with what is the subject proper of the paper, viz., the cost of production, we would refer to one or or two points connected with the financial side of the matter, and to which reference is made by the author. Mr. Hammond almost apologises for going beyond the analysis of the works' costs, on the ground that it may be objected that anything else is outside the province of the engineer; but, although this is true to a certain degree, it is equally true that the extent to which electrical energy will be used does not depend only on the works' cost, but on the total cost, or rather on the price at which the unit can be sold. Although it is quite true that in any existing undertaking the engineer cannot exercise any control over the cost of management, and that he may have had nothing to do with the choice of the system and the design of the plant, so that he is in no way responsible for the amount of the annual charges on capital expended; yet, if anyone is desirous of arriving at a just comparison of two undertakings, it is impossible to leave out of consideration those sums which must be paid out or set aside annually in order that the undertaking may be worked on a sound financial basis. With the local authority there are annual charges which must be met for interest on and redemption of loans, and with companies there are dividends which, from the shareholders' point of view, it is absolutely necessary to pay; and these payments, the amount of which depends on the capital expenditure, must be paid out of revenue, and very materially affect the price at which the unit can be sold, and therefore the chance of success of the undertaking.

We all know that working costs can be kept down by the expenditure of large sums on economical engines and dynamos, on condensing plant, and on works for providing a supply of water for condensing so that water rates have not to be paid, on labour-saving appliances, and on the laying of very heavy copper mains to keep down the cost of distribution; but would it be fair to place such an undertaking in front of another whose working costs are somewhat higher, because it has been deemed advisable not to expend large sums on condensing plant, and on various appliances the use of which tend to reduce working costs, or because owing to local circumstances it has been decided to use smaller mains and transforming apparatus, without taking into account the difference in the capital expenditure of the two undertakings? Of course it may be that the expenditure in the first case is fully justified, and that the total cost of the unit, as we understand it, is lower than that in the second; but there are many cases in which this would not be so, and where the saving in capital charges would more than counterbalance the increased cost of working.

Another point which is discussed by Mr. Hammond is the amount which should be set aside for reserve or depreciation fund. Mr. Hammond agrees with the opinion held by many local authorities, that the obligation in their case to repay the loans to cover capital expenditure in about 25 years is sufficient for all purposes, and that it is not necessary to set aside anything for reserve under these conditions. We con-

sider that those authorities are acting wisely who exercise the power given them by the Board of Trade to set aside annually a sum for depreciation until this reserve amounts to one-tenth of the aggregate capital expenditure; since, although their plant may be kept in good working order by the execution of repairs, yet it does not follow that all the plant will have a useful life of 25 years. For example, is it not probable that, before the 25 years have expired, some of the boilers may no longer be fit for use at the high pressures which are now generally employed? They may have been maintained in good condition, but it is a common thing to find that, after 10 to 12 years, the boiler insurance inspector insists on a reduction of working pressure, and in such a case, although the boiler may be perfectly serviceable for continued use at this reduced pressure, it is no longer suitable for the service required of it in the central station.

Again, it often happens that a station starts operations with generating units which are found to be too small after a few years working, and have to be taken out to make room for larger units; and it would be sounder finance to pay at any rate a proportion of the cost of this charge out of a depreciation fund, rather than to create fresh capital charges for the whole. We have, so far, spoken only of local authorities, but the same remarks apply to companies; and, indeed, these latter, in the great majority of cases, do not set aside as much as the 3 per cent., which is the average annual charge for the redemption fund of the local authority. Although it may not be advisable to handicap an undertaking in its earliest years by a heavy charge for depreciation, we think that as soon as it is possible to pay a dividend which will keep the value of the shares at par or a little over, it would be better finance to devote any surplus revenue in the first instance to building up a reserve fund, and that in considering the possible minimum gross cost of the unit when supplied by a well established company, a charge of something like 5 per cent. should be included for depreciation and reserve.

These general questions are of interest in considering an extract from our contemporary, the *Engineer*, which was quoted in the paper and commented on by Mr. Hammond. This extract, after stating that it is only under peculiar circumstances that the unit can be obtained at a less price than 5d., concludes by saying: "For about 20 years we have been told that its cost is to be reduced next year. The reduction has not come yet; and the worst of the matter is that all the large producing companies, who ought to know—and who are for the most part keenly competitive—tell us that they see no prospect of being able to reduce the price." Mr. Hammond justly takes exception to the first part of the paragraph we have quoted, and points out that both the cost of production and the selling price of the unit have been very largely reduced, since the first pioneer companies started operations less than 20 years ago. But on the question of the gross cost of production, or, rather, on the probable minimum selling price of the unit, Mr. Hammond says very little; and we think that our contemporary, as we ourselves should, would rather that Mr. Hammond should have dealt more fully with this part of the subject, and have given us his ideas of the probability of a general reduction of the price below 5d. per unit.

With a company much depends on what the directors consider a proper remuneration to their shareholders, but with a local authority, where there are no shareholders to consider, and where the charges for interest and redemption are fixed, it is possible to get some idea of the minimum selling price which would pay the works' costs and the charges for management, interest, redemption and depreciation. If we consider the balance-sheets for 1896 of five of the leading Coporations, Bradford, Brighton, Edinburgh, Glasgow and Manchester, we find that their aggregate capital expenditure at the end of the year was £965,000, and that they sold during that year 7,930,000 units, at an average price of 4·46d.; and further, that after paying the cost of production, including management, and the interest on their loans, they set aside £41,500 for depreciation and redemption fund, and still had a surplus of £29,500. The average cost per unit sold, including rent, rates, taxes, management, &c., was 1·62d., to which interest on loans added ·69d., and depreciation and redemption fund 1·26d., making a gross cost of 3·57d., which is therefore the average price at which the unit might have been sold if no surplus had been made. The amount set aside for depreciation and redemption fund varies considerably, Glasgow having set aside over 8 per cent., whilst Brighton's figure is little over 2½ per cent.; but if we allow a uniform charge of 2½ per cent. for interest, and 5 per cent. for depreciation and redemption fund taken on the capital expenditure at the end of the year, we find the gross cost per unit sold would have been 3·81d., so that we may confidently expect that, for important undertakings, local authorities will be able to supply at an average price of 4d., and that at that price the undertakings will be on a thoroughly sound financial footing, and will have a margin to spare after the payment of all charges.

(To be continued.)

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(Continued from page 356.)

The curves given in figs. 14 and 15 are typical of the excellent single-phasers made by this firm. Fig. 14 gives the efficiency, power factor, and speed regulation of a 110-

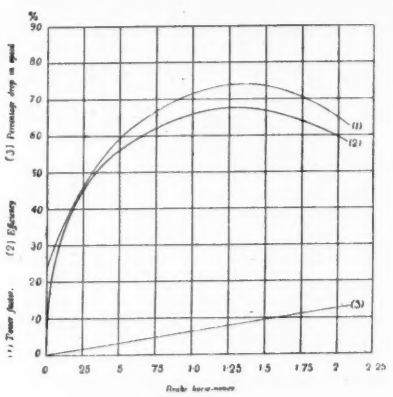


Fig. 14.

volt, 40 ~, 1½ H.P. motor fitted with simple short-circuited bar armature. It will be seen that the power factor and efficiency are both high over a considerable range, and the speed regulation is also very good, especially when the small size of the motor is taken into account.

Fig. 15 shows the same thing for a six-pole motor designed to give out 3 H.P. at 100 volts and 100 ~. It had a wound

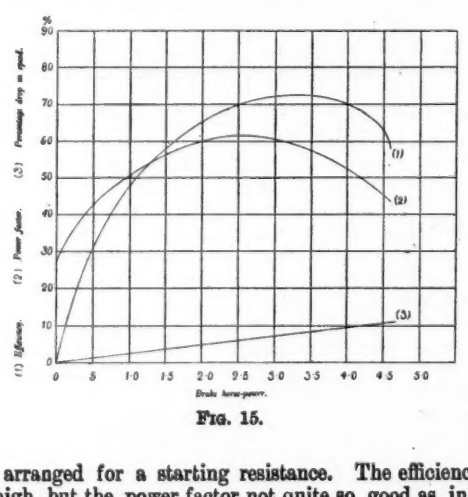


Fig. 15.

rotor arranged for a starting resistance. The efficiency is very high, but the power factor not quite so good as in the last case, owing to the greater number of poles. The starting torque was equal to the full load torque when the starting current was allowed to be about twice the full load current.

Fig. 16 concludes this account of the Brown single-phasers. It is a 70 H.P. motor, working on the Frankfort 45 ~ 2,800-volt lighting mains, and runs at 540 revolutions per minute. The starting arrangements have already been shown in fig. 12B.

(*B*) *The Oerlikon Company.*—This is another company who were early in the field with single-phasers. Their constructions do not call for special notice, as they are very similar to those of the last firm. Their starting device is, however, somewhat different, owing to the fact that a choking coil is used instead of a condenser. The motor being wound with two windings, a choking coil is put in series with the one of greater self-induction, which is generally the starting winding with many turns, and a non-inductive resistance in series with the working winding. The two are put in parallel across the mains, when the difference of phase produced is large enough to start the motor up on a loose pulley. Sometimes the non-inductive resistance is left out—and a rotor resistance is always used for the larger units. This starting device requires more current than the previous ones described, and, generally speaking, is not so effective.

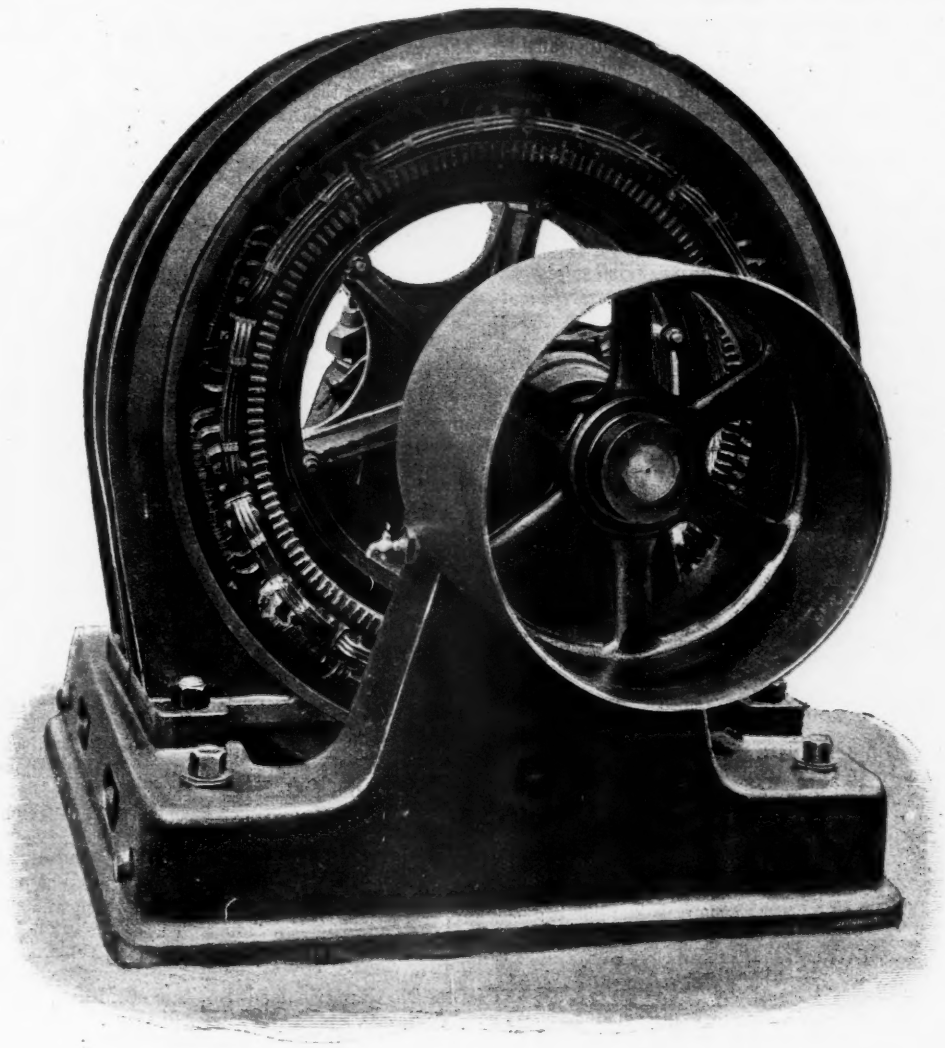


Fig 16.

(*C*) *Messrs. Kolben & Co.*—This firm is the latest making a speciality of alternate current plant, and especially of induction motors. Their single-phase motors show in their design that attention to detail which would be expected from Mr. Kolben's large experience with this class of work. The accompanying table gives some interesting information in regard to the low tension motors for 50 ~ circuits made by his firm.

Table II.

Horse-power	·2	·75	2	3·5	6	10	15	20
Full load efficiency (per cent.)	55	64	68	72	76	80	82	83
Half " " "	42	53	56	60	65	69	72	73
Full load watt consumption	270	960	2,160	3,600	5,800	9,200	13,500	17,800
Half " " "	170	520	1,300	2,150	3,400	5,700	7,700	10,000
Full load power factor (per cent.)	65	68	72	73	75	80	80	82
Half " " "	48	51	55	56	60	62	62	64
Amperes at starting } At "	7·5	18	38	50	65	90	120	145
" " full load } 110 volts.	3·8	11	27	45	70	105	154	200
Revolutions per minute running light	1,500	1,500	1,500	1,500	1,500	1,500	1,000	1,000
" " fully loaded	1,350	1,390	1,400	1,430	1,430	1,430	965	965

(*To be continued.*)

CORRESPONDENCE.

The Burning Question.

The interesting communication of your correspondent, A. J. Liversedge, again prompts me to trouble you with a few lines upon the above subject, and to join with him in expressing personally my thanks for the opportunity you have given for full and free discussion in your valuable paper, the ELECTRICAL REVIEW, and it is at the present moment that we are particularly grateful, for although much has been "utterly erroneous," the time is evidently rapidly approaching when "Eureka" will be your proud motto blazing forth above the portal of your office in all the beauty given by 10,000 incandescent lamps, the outcome of the now all-powerful compound "pressed sludge and house refuse." That I am right in this conclusion I feel quite sure. Mr. Liversedge virtually says that "Now we shan't be long," and I will not attempt for one moment to go behind the happy conclusions at which he has arrived; at the same time it would be more satisfactory when figures are quoted as to the cost of burning, that it should be clearly stated whether or no the capital charge, principal and interest has been taken into account. There are so many items to be fairly dealt with, that I need not make any apology for the suggestion. Mr. Liversedge's reference to a previous correspondent whose "imagination" went somewhat astray with respect to what takes place at Ealing is very much to the point. I did not reply to the said previous correspondent, time I felt was "too precious." I may, however, now add to previous information that one-third of the house refuse is used in the drainage of the sludge, the remaining two-thirds is tipped on the destructor in the ordinary way and all burned together; the drainage goes on usually for seven days. One thing is certain, that although I have tried again and again the burning of *pressed* sludge, I have never succeeded in obtaining as a result a good hard and useful clinker such as I obtain from the compound produced at Ealing.

Mr. Liversedge has referred to a communication I made some years ago to the old Metropolitan Board upon this question, and in looking over my papers I turned up one of my lectures 1890 which deals with this very point. In eight years necessarily there have been change and improvement, but the general remarks will apply almost as well to-day as when they were written, and as it may interest some of our readers, the following extract gives the principal points:—

> I have spoken and written upon this subject of house refuse and sludge burning for some years past, and I called the attention of the Metropolitan Board to the matter, but without effect. Although they did carry out some experiments, they were carried out in such a way that it was impossible for them to succeed, so little did their officials know about it. At the discussion at the Institute of Civil Engineers upon Mr. Dibden's paper upon "Sewage Sludge," Mr. Dibden said: "Mr. Jones did not contend that he could burn the unpressed sludge, but only the pressed, and based upon that an enormous annual outlay for the purpose of pressing. But the real fact of it is, gentlemen, I have never pressed a ton of sludge since my destructor has been in work, but it is mixed with house refuse, goes into the furnace in almost a semi-liquid state, and is delivered as a hard and valuable clinker. Mr. Dibden stated that before the pressed sludge can be burned the water must come out by heat, but he concluded with these significant words, that if dust-bin refuse of a town is available, doubtless the object can be attained by the use of destructors." In these few words I maintain that you have the solution to the difficulty. Why should not the Metropolitan Board of Works have had the refuse of the dust-bin? The various authorities along the banks of the Thames would have been only too glad to have had a depôt, and barge it down to the northern or southern outfall. We all know the trouble that for years and years has gathered round this question, when a remedy so readily might have been found. I have been told that the quantities are so large, and the amount of sewage is so great; but it seems strange in these days of the Forth Bridge to hear words of this class. The whole treatment of the London sewage at two outfalls would be a mere bagatelle, if those with whom the matter rests would face the difficulty. I have stated that in England at the present time there are some 200 cells at work employing less than 100 men, and dealing with something like 500,000 tons of refuse. How much room do you think these 200 cells would take, supposing they had been built at Barking, where, I believe, there are some 70 acres of land available? You will be surprised to hear that they can be put upon an acre of land, with plenty of room to work between them, and that the cost of erecting them would not amount to more than £300 or £350 per cell. Supposing the 200 cells had been built, and the question tried, there would have been, according to the data which we have, and which there is no disputing as it is in daily work, 1,000 H.P. at hand, or in other words, the coal bill would have been saved. No nuisance would have been created by the adoption of the process, which after all that has been said with respect to other systems, has held its ground, and will do so still. I refer to the milk of lime process, which will ultimately come about. I know that it may be replied that the effluent that is turned out by this process is not pure. No one in the present day would say that it was, but the question is, is it not pure enough to be discharged into the Thames at Barking and Crossness? I have been sending, to the satisfaction of the Thames Conservators, from 750,000 to 1,000,000 gallons of effluent per day for many years into the Thames, and many visitors have made the remark, and not a few of them members of the Metropolitan Board of Works, why cannot we do the same, and I say unhesitatingly, that under the lime process and the destruction of refuse, as suggested by me, the river would assume a character in every way satisfactory, and at a mere bagatelle of cost when compared with the expensive schemes already referred to. Other points might be raised in connection with this effluent water, for instance, that of aeration. And here I may add that sufficient steam would be produced from the refuse, over and above the quantity required for ordinary pumping purposes, which might be brought to bear upon the effluent in aeration, and which, to my knowledge, can be productive of immensely beneficial results.

Charles Jones, M.Inst.C.E.

Ealing, *March*, 1898.

Electric Power Supply from Central Stations.

I am obliged by the length at which you have reviewed my little paper on "Electric Power Supply from Central Stations." The paper was read at short notice before a body of men who are not specialists in electricity; it was also desired that it should not take more than an hour in delivery including the exhibition of some 30 lantern slides. Further, it is to be remembered that the proposals of the Midland Electric Corporation are still *sub judice*, and that until it is settled over what areas they will have powers it is very difficult to speak exactly from an engineering point of view. For all these reasons then the paper was qualitative in character and tone, rather than quantitative.

As regards your suggestion that more actual figures as to the capital cost of water power installations should have been given, it would have been beside the purpose of the paper to have treated this part of the subject in greater detail. In the discussion, however, which followed, the president, Mr. J. W. Hall, gave some actual figures entirely confirmatory of my general conclusions, of which I enclose a copy.

Coming now to your criticism that in estimating the relative cost of coal and stoking for a plant running continuously, as compared with a plant working 54 hours per week, I had not made sufficient allowance for "Power Factor."

Allow me on this point to refer to a paper on the "Electric Transmission of Power," read on December 8th, 1894, before the North of England Institute of Mining and Mechanical Engineers, by Mr. Alexander Siemens.

On page 5 the paper reads as follows:—

"As far as they go these comparisons prove that the electric transmission has been economical, but in order to obtain satisfactory information as to the performance of the plant, a series of tests were conducted by the experimental department under the direction of Dr. Eugene Obach, as follows:—

"The boiler tests and the engine tests were carried out separately in two series. The first series was intended to determine the weight of steam generated per pound of fuel, and this test extended over a month of ordinary working, and included all necessary coal for lighting up. The second test series was intended to determine the weight of steam required by the engines, per Board of Trade unit delivered to the distributing bars of the central station switchboard. This was found by exhausting the engine under test into the main condenser, and measuring the overflow from the air pump, taking care that no other could mix with overflow.

"These engine tests were subdivided again into two kinds:—(1) Running on steady artificial loads of about one-quarter, one-half, three-quarters and full load, and (2) running on the ordinary day load.

"*The second set of tests was undertaken to see if a varying day load required the same weight of steam per Board of Trade unit as a perfectly steady artificial load giving the same output. This was found to be the case, the point obtained by the day load test fell exactly on the curve obtained on the steady load tests.*" (Fig. 6, Plate 15.)

In a central station with a number of engines, those working would always be near their economical load, and

boilers give a high efficiency when worked at low rates of evaporation.

In the case of the Midland Electric Corporation there is every reason to anticipate that with good management a better load factor than 54 hours per week will be secured, even without the use of accumulators.

I now come to your remarks on the rates it is proposed to charge for power by the Midland Electric Corporation.

As a matter of fact there is nothing in my paper as to the rates at which the Midland Electric Corporation actually propose to supply power. What I did say is as follows:—"In their agreements with the local authorities, who have so far come to terms with the Midland Electric Corporation, the following are the rates for power supply, which are not to be exceeded: 3d. per unit for first hour's use per diem, taken on the maximum demand in any quarter, the number of first hours being taken as 78, *i.e.*, 6 days per week for 13 weeks, ·825 of a penny for each subsequent hour's use."

I did not say that these are the terms on which the Midland Electric Corporation have determined to supply, *but these are the terms which they have agreed not to exceed.*

In electric lighting orders it has been usual to specify that the maximum charge for supply shall not exceed 8d. per unit. It does not necessarily follow from this that the company or authority will charge the full maximum even to start with, nor that they will charge large and good customers the same rate as the small ones.

The actual rates for power supply I must leave to the future, all I will remark is, that there is no reason to doubt that as time goes on, power supply undertakers will be able to make as great a reduction in their initial maximum rates as electric light undertakers have been able to make on the maximum rates of electric supply for lighting during the last 10 years.

Further, coming to your comparison of the cost of power generated by an isolated plant with the rates per annum the Midland Electric Corporation would charge under similar conditions, I am pleased to see that you acknowledge that even on the assumptions you make, for any power up to 50 kws., it would be advantageous to take supply from the Midland Electric Corporation, the user securing all the advantages of electric working into the bargain.

A 50-kw. plant needs an engine of at least 80 I.H.P to drive it, and as there is usually some saving in power in employing electricity, you appear to agree that there would be advantages in replacing every engine in the district working under the conditions you mention as ordinary ones, up to 100 I.H.P., the advantages increasing very rapidly as the sizes got smaller.

Now 100 I.H.P. is a considerable size for the engine of ordinary engineering and manufacturing works, excluding rolling mills, textile factories, and some other industries; such an engine implies a factory employing approximately 150 to 200 men under present conditions.

But your comparison even on this basis does not include anything for spare boilers or plant, either mechanical or electrical, in the case of the isolated plant—a most important consideration to a manufacturer; while by taking power from the central station he would have nearly the security of duplicate plant. Lastly, you assume that the maximum load to be met with will be double the average load, which, as a general statement, is no doubt accurate. The deduction which you make from this, however, that it is proposed to take full advantage of this fact in supplying current from the central station on the demand meter system, is not correct.

It is one of the great advantages of centralisation that the wider the range of supply the less are sudden local increments of power felt, and it has always been the desire and policy of the directors of the Midland Electric Corporation to give manufacturers, as far as reasonably could be done, the benefit of this.

While, consequently, they have decided to supply electric power on the demand meter system, it is not their intention to do so with the aid of recording wattmeters or ammeters. What they do propose is to use something of the character of Mr. Wright's instrument, which takes some time to reach a maximum reading.

In this way the maximum demand will not bear an undue proportion to the average, so that the average cost of power to manufacturers will be less than you assume, even taking the full rates which the Midland Electric Corporation have undertaken not to exceed.

Although it is not alluded to in the paper, the Midland Electric Corporation proposals also include the provision of electric lighting over a large district at cheaper rates than the authorities could do it for themselves, even if they cared to embark in the necessary capital expenditure.

While, therefore, your conclusions are generally favourable to the Midland Electric Corporation's enterprise, I think you will agree, after this explanation, that their proposals, if the local authorities allow them to be carried out, will be considerably more advantageous than your leading article indicates.

Remember, also, that this is what prudent men, after carefully weighing the circumstances, feel that they can do to start with, and it is always the beginning that is the difficulty.

I am sorry to have written you at such length, but in justice to the directors who have spent much time on the undertaking, and especially the chairman, Mr. J. F. Albright, it is important that there should be as little misunderstanding of their proposals as is compatible with the inauguration of a new enterprise, and one which to a considerable extent breaks fresh ground.

G. L. Addenbrooke.

The Association of Electricity with Atmospheric Phenomena.

Your correspondent, "Delta," will perhaps be interested to hear that early on Tuesday, the 15th inst., a similar phenomena to that of the Aurora Borealis was seen from Blackpool and Thirsk and at other northern towns; and about the same time and day a *water-spout* was seen from the coast of the Isle of Man. This is a remarkable coincidence, and points to an electrical association. Perhaps some of your readers could say whether there were any striking barometrical changes on the date named in the places mentioned.

Magnet.

LEGAL.

LEICESTER CORPORATION *v.* WARREN HILL.

Important Judgment.

At the Leicester County Court on Friday, his Honour Judge Wightman Wood delivered judgment in the case of the Leicester Corporation *v.* Warren Hill, electrician, King Street, Leicester.

His Honour said the case, which was heard last month, was one of unusual importance to come before a court of limited jurisdiction. The action was in respect to the price of lamps and other fittings used in connection with electric lighting, sold and delivered to the defendant, who, whilst admitting the purchase, said that it was *ultra vires* of the Corporation to trade in such articles, and that they could not maintain an action for the price. He (the Judge) further understood that the claim was resisted in order to test the right of the Corporation to deal in such things. Under the Electric Lighting Act of 1882, the Corporation were licensed by the Board of Trade to supply electricity for public and private purposes, and besides laying wires, erecting the necessary machinery, and supplying the electric energy to such householders as liked to have it, they had also opened an emporium—he supposed they did not term it a shop—for the sale of lamps and such other fittings as were required in houses by persons who made use of the electric light. No attempt was made to confine the sale to householders who took the electricity, nor was the defendant such a person. He was an engineer with a similar business of his own, and the articles which he purchased from the Corporation he added to his stock. All the facts were admitted, and the matter in dispute was entirely a question of law. A corporate body could only do such things as it was authorised to do by charter, Act of Parliament, or means of association which brought it into being, or supplementary Acts or charters, including all such things as were necessarily incidental to the expressly authorised objects. All other things it was prohibited from doing. The plaintiffs' charter was not produced, and it was conceded by their advocate that no right to trade could be deducted therefrom, and he relied entirely on recent electric lighting legislation. Having reviewed the various sections of the Acts of 1882, 1888, and 1890, his Honour said he could see nothing by reasonable implication to authorise the Corporation to supply any material fittings except meters. The Corporation advocate, however, had placed great reliance on a form of account sent down by the Board of Trade, and it certainly appeared from that form that the person who drew it up contemplated that the Corporation would buy and sell lamps and other apparatus, and it might be that the Corporation had taken their cue from it, and had taken to trading in

lamps on the strength of its wording. He was, however, of opinion that a mere indication by a Government department that in its judgment a thing may be properly done, could not have the effect of authorising that which would otherwise be contrary to law. Section 9 gave the Board of Trade no authority to authorise anything at all, but merely to prescribe the form in which the Corporation were to present their accounts "of the undertaking" authorised by the Act—that was, the duty of supplying electric energy. *He was therefore of the opinion that the contention of the defendant that the Corporation had acted beyond their legal powers in selling the articles in question was correct.* Defendant, however, having taken and kept the goods under an implied promise to pay, the question arose, "Could he now set up as a defence to an action for the price that it was *ultra vires* of the Corporation to sell?" In his (the Judge's) opinion he could not, for the defendant having had the goods, could not be allowed to refuse to pay for them on the ground that the Corporation went beyond their legal right in selling them, and could not have been held to their contract to deliver them had they refused to do so. The defendant had got what he bargained for and he must pay the price, notwithstanding the flaw which he had rightly called attention to in the capacity of the Corporation to carry on their business. As he was against the plaintiffs on the point on which they relied, and which the parties came there to contest, he would give no costs, and judgment would therefore be entered for the plaintiffs for £4 19s. without costs, with leave to appeal.

VAUGHAN & BROWN *v.* TERRY.

AT the Clerkenwell County Court on Friday last, plaintiffs, electrical engineers, of Kirby Street, Hatton Garden, sued Mr. Edward Terry for £9 14s. 8d. for work done in connection with Terry's Theatre. For plaintiffs it was stated that the order had been given by Mr. Brickwell, Mr. Terry's business manager, and Mr. Brickwell gave evidence that he had acted in that capacity in giving the order to plaintiffs. Mr. Terry gave evidence that Mr. Brickwell was, at the time this contract was given, temporarily acting for Mr. Carr at 15 guineas a week. He never authorised Mr. Brickwell to carry out the work claimed for. The deputy-judge (Mr. Horton Smith) found for the defendant, with costs.

BUCK & HICKMAN *v.* BINKO & Co.

THE plaintiffs in this action, a firm of tool manufacturers, sued Mr. Henry Binko, electrical engineer, of 34, Leadenhall Street, at the Lord Mayor's Court, before the Recorder, to recover the sum of £16 2s. 4d. in respect of goods sold and delivered. The defendants pleaded that the whole amount was tendered before the action was brought, and the sole question was as to whether there had been a proper tender. Mr. Henry Binko stated that in January last he received an application from Messrs. McKenna & Co. for an amount of £16 2s 4d. due to plaintiffs. There was a dispute at the time between him and plaintiffs over a sum of 4s. 5d. Witness drew a cheque for £15 17s. 11d., and subsequently, after his attention had been called to two credit notes for the 4s. 5d., he added another 4s. 5d. That amount was taken on to plaintiffs, but was refused on the ground that the matter was out of their hands. The plaintiffs contended that the amount tendered to them was £15 odd, and as that was not the full amount, they refused to accept it. Eventually the jury found for the plaintiffs for the amount claimed.

WILSON *v.* ELLIS.

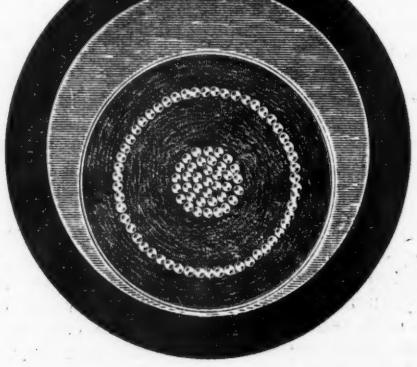
THIS was a claim by a traveller for £28 odd for commission for orders for electrical work obtained for the defendant, who has an office in the district of the Westminster County Court, and a branch at Croydon. Plaintiff, it seemed, obtained an order from the builders who were reconstructing the "Old George," Croydon, to do the wiring, and for that he was entitled, with other jobs, to £11 commission. Subsequently, through his introduction, defendant obtained the order for fittings. Defendant's case was that the order for the fittings came through another servant of their's and that plaintiff knew nothing of the order for fittings until after it had been obtained. They had paid the other amounts into Court, but this £18 they did not think he was entitled to. His Honour, in giving judgment for the plaintiff, said the introduction came through him, and but for that defendant would not have obtained any order at all.

BUSINESS NOTICES, &c

American Competition in Europe.—Mr. F. H. Mason, United States Consul-General at Frankfurt, has, says the *Times*, given some interesting information on the subject of American competition in Europe in his annual report to his Government. He states that 1897 will be remembered as an epoch in the industrial and commercial relations between the leading European countries and the United States. The remarkable fact of the year has been the enforced recognition of the truth that in several important lines of manufacture—notably that of iron and steel—the sceptre of economical production, combined with the payment of the highest wages to labour, has passed from the old world to the new. It has been demonstrated that, under intelligent, progressive management, highly paid labour, especially when employed to use complicated machinery, is, after all, the cheapest, and that in the race for supremacy the people of the old world have been in many cases left behind by those who, more than any other, have reduced economy of labour to an exact science. It is now seen that it is something besides the tariff that has made the cost of producing Bessemer pig iron from 10s. to 15s. per ton less in the United States than Great Britain, has enabled the steel-makers of Pennsylvania to underbid those of England for the rails and other supplies of the London underground railway, and to place an order for 8,000 tons of steel rails with the Indian Government. Neither has fiscal legislation enabled the machinists of Philadelphia, Pittsburg, and Chicago to sell locomotives, mining and electrical machinery, tramway outfits, bridges, and architectural iron in competition with British, German, and Belgian agents in South America, Australia, and the Cape of Good Hope. The leading makers of electrical machinery in the United States have set a standard of cheapness, prompt delivery, efficiency, and economy of service, especially in electrical railway plant, with which their European rivals find it difficult to compete.

Birmingham Electrical Exhibition.—The installation for lighting the buildings of this exhibition at Bingley Hall was put down by the Walsall Electrical Company. Messrs. Henry Sassons and Co. have an effective display of fittings, and there are exhibits by a large number of electrical firms. There are to be wireless telegraphy, and X ray demonstrations.

Brook's Semi-solid System of Insulation.—Messrs. Johnson & Phillips have issued a pamphlet on the above system. We understand they have had experience of these cables for the past eight years, and are convinced that they are an advance in the right direction as regards the transmission of electrical energy. No faults have occurred on the lines laid; but, on the other hand, the insulation measured in megohms, and, what is of more importance, the insulation as regards dielectric stress, is in all cases higher to-day than when originally laid. We illustrate a full size section of the ·15 square inch high tension concentric cable supplied for the Corporation of Worcester, which has relied for some years on two Brook's mains for connecting the city with the generating station some three miles in the country. The pamphlet before us describes



the Brook's system in detail, together with the method of laying and jointing. In this system the copper conductors are closely and thickly covered with two helical bindings of strong fibrous material impregnated with a highly insulating compound. The cables are drawn into thick iron tubes, which are afterwards filled with a highly insulating semi-solid dielectric and hermetically sealed. The cables are thus completely protected from all deteriorating influences. It is claimed that with the use of this type of underground cable there is a great factor of safety against faults, an absence of material exposed to any action likely to deteriorate it, and by its use one has an insulation as reliable and permanent as is possible.

Catalogue.—Messrs. Binko, Ridsdale & Co., Limited, of Leadenhall Street, and Minories, have issued a 290-page catalogue, bound in red cloth covers, in which they describe, illustrate, and give prices of the great variety of electrical apparatus and accessories, in which they trade. Department I. covers electric signals, electric telegraphs, telephones, electric bells, fire alarms, lightning conductors, and medical appliances. Section II. is devoted mainly to electric lighting, and describes accumulators and fittings for ships and domestic use, dynamos, and motors, &c. The book will be of service to the firm's customers, and the electrical trade generally.

Crompton & Co., Limited.—The petition presented to the Courts for confirming a special resolution reducing the capital of this company from £280,000 to £162,000, will be heard by Mr. Justice Wright in the Chancery Division, on April 6th. Anyone desiring to oppose the proposal should then appear.

Dissolution of Partnership.—Messrs. A. Harrison and E. C. Pringle (trading as Harrison, Coles & Co., electrical engineers, Hermitage Works, Richmond, and Kensington) have dissolved partnership.

Electrical Wares Exported.

Week Ending March 29th, 1897	£	s.
Albany	800	0
Amsterdam	800	0
Antwerp	56	0
Auckland	35	0
Bilbao	10	0
Bombay	125	0
Calcutta	176	0
„ Teleg. mat. ...	36	0
Colombo	85	0
Copenhagen. Teleg. cable	364	0
Delagoa Bay	107	0
Durban	340	0
East London	7	0
„ Teleg mat.	1,890	0
Flushing	110	0
Hamburg. Teleg. mat ...	505	0
Hong Kong	17	0
Madras	171	0
Melbourne. Teleg. mat.	683	0
Ostend	24	0
Otago	27	0
Passages	135	0
Perth	438	0
Port Elizabeth	225	0
Rouen	32	0
Santos	25	0
St. Petersburg. Teleg. mat.	268	0
Shanghai	157	0
„ Teleg. mat.	35	0
Singapore	43	0
„ Teleg. mat.	234	0
Stockholm	70	0
Sydney	648	0
Trinidad	10	0
Wellington	52	0
Yokohama	60	0
Total ...	£8,800	0

Week Ending March 29th, 1898.	£	s
Alexandria. Teleg. mat.	426	0
Amsterdam	200	0
Bangkok	467	0
Bilbao	88	0
„ Teleg. mat. ...	790	0
Boca	77	0
Buenos Ayres	225	0
„ Teleg. mat.	100	0
Calcutta	196	0
Cape Town	1,437	0
Colombo	848	0
Durban	1,707	0
„ Teleg. mat. ...	1,097	0
East London	513	0
Flushing	8	0
Gibraltar. Elec. cable	700	0
Gothenburg	133	0
Hamburg	10	0
Hong Kong	14	0
Launceston	14	0
Madras	218	0
Malta	54	0
Natal	78	0
„ Teleg. mat. ...	1,945	0
Passages	107	0
Perth	200	0
Port Elizabeth	31	0
Port Said	13	0
Rangoon	345	0
Rio Janeiro	20	0
Rosario. Teleg. mat. ...	60	0
Santos	26	0
Seville	100	0
Shanghai	271	0
„ Teleg. mat.	350	0
Singapore. Teleph. mat.	45	0
Spezzia	650	0
St. John's, N.B. ...	10	0
Stockholm. Teleg. mat.	122	0
Sydney	441	0
Tientsin	35	0
Wellington	85	0
Yokohama	585	0
Total ...	£14,881	0

Foreign Goods Transhipped.

	£	s.
Monte Video. Teleph. mat.	9	0
Sydney. Teleph. mat.	74	0
Total ...	£83	0

Electrical Installation at the Thames Ironworks.—The Institution of Junior Engineers will to-morrow (Saturday) morning pay a visit to the Thames Ironworks and Shipbuilding Company's works at Blackwall. The following notes on the electrical engineering department are of interest. The central generating station has been established in the works near the shipyard gate. The installation consists of three locomotive and two "Gunboat" boilers—the latter of the company's manufacture—aggregating 600 I.H.P.; engines and dynamos aggregating 360 I.H.P., three of them built by the company. Distribution of current is effected by three-wire system, the main cables to distributing centres being of vulcanised India-rubber insulation, laid in cast-iron pipes underground. The electric current generated is chiefly used for lighting purposes, but several examples exist in the works of the use of electromotors, and the use of electricity for power purposes is in course of extension. Electric drilling machines are a speciality. Several types of these machines are found on H.M.S. *Albion*, in shops of the shipbuilding department, and in various parts of the yard. Others are under construction in the upper machine shop of the engineering department. Dynamo and motor construction is carried on as a branch of the engineering department (upper shop). Electro-galvanising of boiler tubes, plates, &c., is seen near as. *Diogenes* and alongside boatbuilding sheds. Current for plating is obtained by transformation from the electric lighting mains.

Elmore Director's Fees.—At the Leeds Assizes on Saturday last, Mr. Justice Ridley gave judgment for the plaintiff in the case in which Mr. J. North, solicitor, of Leeds, sued the Elmore's Patent Copper Depositing Company, of London and Leeds, for £600, as director's fees. For the defence it was argued that directors' fees had been held to be a gratuity and could not be sued for. His Lordship, however, ruled against this point.

Fires.—On Saturday last a fire occurred on the premises of Messrs. Downie & Adams, electrical engineers, Newman Street, Oxford Street, W. The fire originated in the showroom of Messrs. Wenham & Waters, and Messrs. Downie & Adams ask us to state that their business has not been in any way interfered with by the occurrence.

On Saturday last a fire occurred on the premises of Messrs. C. and G. A. Parson, electricians, George Street, Bath, and did considerable damage.

On Thursday night last week, a fire occurred on the premises of Messrs. Hamer & Co., electricians, in Herton Street, Halifax. The building is a three-storeyed block.

Electric Light Fittings.—Messrs. H. M. Salmony & Co., of Charing Cross Road, have brought out a new catalogue. The copy before us is an *edition de luxe* of about 400 pages, including section P.A., describing electric light plant and accessories; section F.G. dealing with electric light fittings and glassware; and section H.C.

Fig. 1.

particularising electric heating and cooking apparatus. We can only afford space for brief mention of the great variety of machinery and apparatus which is well illustrated and clearly printed in this volume. Section P.A. deals with dynamos, motors, combined plants (gas, oil

Fig. 2.

and steam), turbines, accumulators, arc lamps, switches, cut-outs, measuring instruments, &c. The electric light fittings section embodies a really excellent selection of artistic fittings, such as brackets, standards, electroliers, ceiling fittings, &c. For neatness of

Fig. 3.

design and general arrangement they compare very favourably with anything of the kind that we have seen. We select a few of the specimens for illustration. Fig. 1 shows a three-light pendant in brown or grey bronze, with spray for the lamps. In fig. 2 is shown

a bracket made in either polished brass, dead gold or wrought iron. A high-class ceiling fitting with hand-wrought leaf work is shown in fig. 3, with three lights. This is made in polished brass or copper. Fig. 4 shows a six-light electrolier, made either in polished brass or dead gold, with cast brass leafwork and ornaments, and cutglass

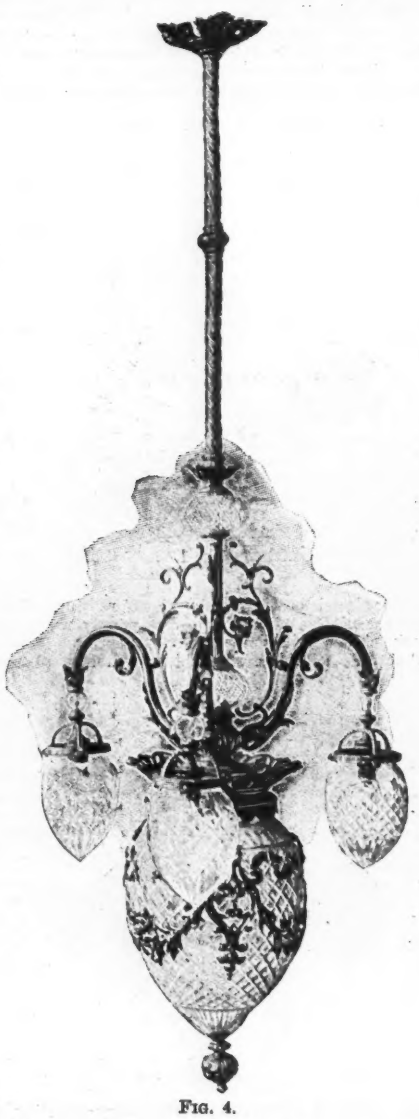


Fig. 4.

shades. These are only a few specimens selected off hand from the catalogue, but at the very complete showrooms in Charing Cross Road a great variety of excellent fittings can be seen to greater advantage than in illustrations. To facilitate the visits of contractor's customers to the showrooms a sheet of perforated introduction cards is given with each catalogue.

Holophane, Limited, v. the Stewart Electrical Syndicate.—In the Chancery Division on Friday last, before Mr. Justice North, Mr. Eady, Q.C., mentioned a motion in this case for an injunction to restrain the infringement of patents and passing off. Counsel stated that the motion was adjourned from last week, and since then an arrangement had been arrived at whereby the defendants had agreed not to dispute validity, and to submit to a perpetual injunction with inquiry as to damages and costs.

Lists.—Mr. J. D. Sutcliffe (of Sutcliffe, Statham and Co., Fennell Street, Manchester), sends us a copy of a paper read by him before the Manchester Society of Architects, on "Combined Warming and Ventilation of Public Buildings."

Mr. A. W. Roy, of Heaton, Newcastle-on-Tyne, has issued a March, 1898, list of his small dynamos and motors, and materials for same.

Receiving Order.—Messrs. James Fletcher and J. A. Hirst (trading as Fletcher, Hirst & Co., electrical and mechanical engineers, Bankfield Works, Curzon Street, Burnley, and lately at Chester and Derby) filed a petition for receiving order in bankruptcy on March 24th.

To Creditors.—Creditors of Bennett & Druce, lately trading as electrical engineers, at 30, Winckley Square, Preston, Lancashire, who have not already sent in their claims to Mr. J. Todd, receiver and manager, must do so by April 8th, after which date distribution of assets will be proceeded with.

Micrometers.—We have received from Mr. Robert Mühle, of Glashütte, i/S Germany, particulars of three forms of micrometer which he is manufacturing for the use of electrical engineers. For these is claimed the extreme accuracy rendered necessary by the delicate distinctions of diameter and thickness brought into use in modern electrical practice. Fig. 1 shows (half natural size) the

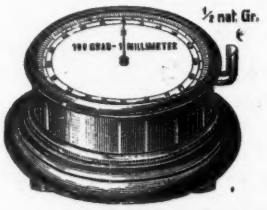


Fig. 1.

standard form of micrometer measuring by $\frac{1}{100}$th mm. This is made either in brass or nickel, the jaws project and are opened by means of a lever to admit the subject for measurement. An arrangement of spring, levers and gear actuates the pointer and shows the actual measurement on an easily read scale. The knife edges of the jaws are finely polished and are made with jewelled points if required, for measuring incandescent lamp filaments, screws, plates, wire, &c. These instruments are also made to read in $\frac{1}{200}$th, $\frac{1}{400}$th, and $\frac{1}{500}$th mm., and are guaranteed not to vary even with constant use. Fig. 2 is

Fig. 2.

another form with extended scale to show extremely fine divisions from $\frac{1}{100}$th mm. to $\frac{1}{3000}$th mm. The opening in this instrument is much larger. In the three sizes made the jaws open 12 mm., 40 mm. and 50 mm., and the largest size can be used up to even 75 mm. The illustration is half natural size. Fig. 3 is a convenient form for

Fig. 3.

workshop use when extreme accuracy is not required, the readings being $\frac{1}{10}$th, $\frac{1}{20}$th and $\frac{1}{50}$th mm. The scale is isometric, thus avoiding circle errors. The adjustment is easy and the instrument is strongly constructed to stand ordinary workshop use. The firm of Robert Mühle was established in 1869, and has devoted a vast amount of attention to the perfecting of measuring instruments, of which the types we describe are good examples.

New Patent Friction Clutch.—The friction clutch illustrated below has been designed by the Unbreakable Pulley and Mill Gearing Company, Limited, of Manchester, to overcome some of the many difficulties attendant upon this apparently simple, but really very exacting class of mechanism. With regard to the clutch proper, it is not greatly different in the main design from some others in the market. The driving power is transmitted by heavy arms or horns, on which the friction blocks slide, so that all strain, except that of putting the blocks into gear, is taken from the screws. These are two in number, right and left handed, and the arm for their rotation is forged solid. The main and lock nuts are gun metal, to avoid any chance of rusting, should the clutch remain for long either in or out of gear. The patented novelty lies in the method of the application of the power from the usual sliding sleeve upon the shaft to the extremities of the screw levers. Instead of the connecting links being carried in rigid centres on the sleeve, as is usually the case (fig. 1), they are pinned to a gimbal or ring, pivoted on the sleeve (fig. 2). It will be seen that, by this arrangement, any pressure put upon the sleeve must be transmitted with absolute equality to the two friction blocks, as either one of these gives the reaction for the other. Any chance of uneven wear on the blocks, or undue strain upon one part of the mechanism is thus avoided. We understand that a number of these new clutches have been sent out, and have been at work for considerable periods. Many repeat orders are stated to have been received. The clutch is made in various sizes, according to diameter of shaft and power to be transmitted, and may be used either to couple shafts or to carry a pulley. Adjustment is provided for in all ways, and all the parts, although guarded by the outer shell, are in full view, and at once accessible.

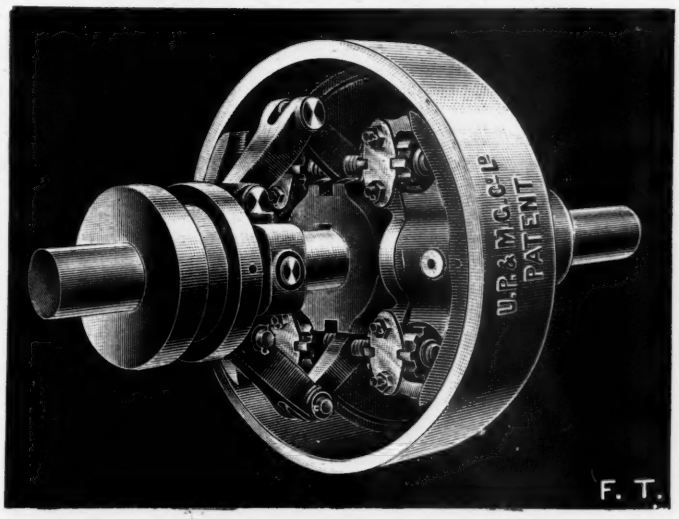
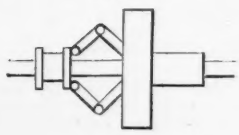


Fig. 1.



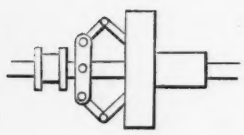


Fig. 2.

Paterson & Cooper.—Discharge Granted.—The case of Paterson & Cooper, electrical engineers and contractors, of the European Works, Pownall Road, Dalston, and Victoria Street, Westminster, with branches at Manchester, Glasgow and Dundee, reached the final stage this week at the London Bankruptcy Court, when Mr. Registrar Brougham granted an unconditional order of discharge to both debtors. The firm failed in August, 1896, with total liabilities £19,514, and assets valued at sufficient to pay the debts and leave a margin of £7,021. The debtors started business in 1883, with a capital of £18,000, and a further £6,600 was afterwards provided. In 1886 they purchased from the inventor, M. Eugene Hermite, a half share in the British and foreign patents of an electrical sanitation and bleaching process. Since then they have been almost continuously engaged in exploiting and working the patents, and have, in one way and another, expended from £12,000 to £13,000 in connection therewith. In 1886 the British patents were sold to a limited company, which proved unsuccessful and entailed a loss of about £5,000 to the debtors. Four years later the French patents were sold to a French company, and the debtors eventually realised £1,800 by the sale of their shares, received in payment of their interest in those patents. For some years before the failure the debtors were endeavouring to form a company to take over the patents, plant, and business of the French company. They attributed their failure entirely to delay in realising their patents. When the discharge was first applied for in January 1897, the Official Receiver reported as an offence that the assets were not equal in value to 10s. in the £ on the unsecured debts. That finding was challenged on behalf of the debtors, and the hearing has since been adjourned from time to time to enable the assets to be realised. Mr. E. Moore, the trustee, now stated that he was satisfied that the assets would realise in the gross sufficient to show 10s. in the £ on the liabilities. The Official Receiver offered, in that case, to withdraw the allegation, and said he would not oppose the granting of the discharge. His Honour remarked that as the only reported offence had now been displaced, he was enabled to grant to the debtors an unconditional order of discharge.

The Stratton Separator.—Mr. C. R. Heap, of 47, Victoria Street, S.W., who is the sole importer in the United Kingdom for the Goubert Manufacturing Company, of New York, sends us a pamphlet, emphasising the necessity of employing dry steam in order to obtain the maximum of economy, efficiency and safety, giving an exposition of the various methods of obtaining it, and describing good points of the Stratton system of mechanical separation. A page illustration is given of a 10-inch Stratton combined separator and steam receiver, connected to 1,200 H.P. compound Westinghouse engines at the power house of the United Electric Light and Power Company in New York City. Other illustrations show separators used by the Philadelphia Traction Company, and the Springfield Street Railway Company. There is a list covering many pages, giving particulars of firms and works in America employing the Stratton separator.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Last week the Gas and Electric Lighting Committee resolved to reduce the cost of electricity for motive power from 6d. to 4d. for the first hour. The price for the current thereafter will be the same as formerly—1½d. The report of Prof. Kennedy regarding the lighting of the west end was deferred until the committee had had another interview with Prof. Kennedy.

Electric light is to be introduced into West Parish Church.

Barmouth.—A movement is on foot to acquire the old reservoir at Ceilwart whereon to erect the necessary plant for generating electricity.

Bath.—The electric light works insurance is to be increased from £12,000 to £20,000. The insurance company has reduced the premium from 7s. 6d. to 5s. per cent.

Barking.—The clerk reported at the last District Council meeting that the provisional contracts for erection of the electric light station, and for supply and erection of generating plant had been entered into, and that the remainder of the contracts would be completed shortly. As to the electric lighting loan, the present application was for sanction to a loan not exceeding £15,000, and the Local Government Board would require the Council to state a definite sum. The clerk and the engineer are to go into the matter, and report the exact amount required. A letter was received from the Board of Trade, stating that if the Council proposed to make an earth connection, the approval of the Board, with the concurrence of the Postmaster-General, would be necessary, and the clerk reported that he had replied that it was proposed to connect the intermediate conductor of the three-wire system with earth, and that the Board of Trade's conditions would be complied with. The Sunderland Forge Company, Limited, wrote, quoting £825 for the duplicate electric lighting plant required, and £75 for copper pipes, including erection. Consideration was deferred.

Bedford.—The stall-holders in the Bedford Market have requested the Corporation to instal the electric light, and have offered to pay 4d. per night per lamp of 16 C.P., which they suggest would produce £176 3s. 8d. per annum. They are agreeable to amalgamate the stallage and charges for light, pay in advance, and sign an agreement to that effect. They prefer, however, the engineer to undertake the complete installation, owing to their employés inexperience in the *technique* of electricity.

The Town Council has decided to reduce the charge for current to 4½d. per unit (5d. less ½d. for cash in a month) from July 1st. Six transformers of increased voltage are to be purchased for the new area at a cost of £300.

Birmingham.—Estimates have been invited for an electric lighting installation for St. Martin's Church, and the work will be done after Easter.

Bridgend.—The Urban Council recently met in committee to consider the application of a London firm of electrical engineers to take over the Council's provisional order for the electric lighting of the town. A committee was appointed to carry out the negotiations with the firm in question and present a report.

Brighouse.—The Town Council is to take over the electric lighting plant belonging to Mr. Brook.

Chester.—At midnight on Thursday last week the electric light works at Chester, with staff, station, and plant, passed into the hands of the Corporation. Since December 17th, 1896, the concern has been run by the contractors, Messrs. Thomas Parker, Limited. All the staff is taken over, with Mr. F. Thursfield, A.M.I.C.E., as resident engineer, and it is stated that for the future Prof. Kennedy ill not be called in for extensions, &c.

Clerkenwell.—The Vestry had a discussion on electric lighting recently. The members are impressed with the successes of municipal plants elsewhere, including Brighton, and it was resolved to apply for powers to supply the parish.

Dingwall.—The Electric Light Committee on 18th ult. considered the draft agreement to be made between the Town Council and the electric lighting company. The company will have the use of the present lamp-posts, and the installation will comprise eight 500-C.P. arc and nine 32-C.P. and 16 16-C.P. incandescent lamps.

Dorking.—A poll of the ratepayers has resulted in favour of the work of electric lighting being carried out by the District Council.

Durban.—£300,000 is being raised for borough improvements, and £50,000 of this is for electric lighting extensions.

Exeter.—At the last City Council meeeting, the Electric Lighting Committee reported that the lamps for street lighting had been delivered, and examined by an electrician sent from London, who had satisfied himself that they were incapable of being adjusted to meet the requirements of the Council. A correspondence has taken place, says the *Western Morning News*, with Drake & Gorham, the manufacturers of the arc lamps to be supplied, wherein they undertook to make a new set of lamps, properly adjusted to meet the requirements of the Council's system of electric lighting, in lieu of those already delivered, and guaranteed the delivery within five weeks from March 8th. The Council has decided to apply to the Local Government Board for permission to borrow £7,000 for additional plant and cables.

Folkestone.—The prospectus of the Folkestone Electric Supply Company, Limited, has been issued this week. It shows that contracts have already been entered into with the Corporation for lighting the most important streets, including the Leas Promenade. The directors include several local public men, viz., Alderman George Spurgen (chairman), Councillor D. Baker, Councillor S. Penfold (Mayor of Folkestone), and Councillor C. J. Pursey.

Gloucester.—Mr. Hammond attended before the Electricity Supply Committee, and submitted a plan showing how he proposed to arrange the Electricity and Dust Destructor Works upon part of the Bearland estate, and conferred with the Committee as to the various kinds of dust destructors. The Committee approved of the plan submitted by Mr. Hammond, subject to any modifications that may be found necessary in working out the details. Mr. Hammond was instructed to invite the following firms to submit plans and estimates for four dust destructor cells:—Messrs. Beaman and Deas; Goddard, Massey & Warner; Manlove, Alliott & Co.; the Horsfall Syndicate, Limited. The foregoing was approved at a meeting of the City Council on Tuesday.

Greenock.—Representatives of the Corporation are to meet the Board of Trade in London this month in conference on the question of the introduction of the electric light into the borough. The North British Electricity Company, Port Glasgow Town Council, and Gourock Commission, will also be represented.

Hackney.—At the last Vestry meeting, says *Daily Tenders*, a letter was read from an electrical engineer, offering his services in connection with the electric lighting schemes, &c., under consideration. It was decided to receive the letter, the opinion being expressed that it was time that these gentlemen should cease advertising themselves.

Hornsey.—The District Council, which is applying for a provisional order, has refused consent to an application received from Mr. F. J. Hider, inquiring whether he would be allowed to carry the cables for a small electric lighting installation in the Broadway, Crouch End, on the low tension system, over a few thoroughfares, with a view to lighting a few of the shops.

Italy.—The report of the Società Anglo-Romana per l'Illuminazione di Roma shows that its electrical branch is now supplying current to an equivalent of 56,698 16-C.P. lamps. An increase of 4,633 lamps during the past 12 months.

Johannesburg.—The price of current has been reduced to 1s. per unit for dwellings, churches, theatres, and public places. The Council has also reduced the price of gas from 21s. to 20s. per thousand, and increased discounts are given.

Leigh.—The District Council has decided to lay down an electric lighting installation at a cost of £10,000.

Leith.—The plans of the electric light station buildings have been approved at the Dean of Guild Court.

London County Council.—At the weekly meeting of the Council on Tuesday, the adjourned report of the Main Drainage Committee in regard to the proposed electric light installation at the Crossness outfall, to which we referred last week, was adopted. It was decided to approve the estimate of £7,000 for the carrying out of the work, and to invite tenders (1) for the supply and fixing of the engines, dynamos, switchboard, and principal mains, and (2) for the service mains, wiring and fittings.

It will be remembered that early in February the Council decided to ask the Board of Trade to give preference to the orders applied for by the Charing Cross and Strand Electricity Supply Corporation in respect of the Holborn and St. Giles districts over that applied for by the County of London and Brush Company for the same area (which the Metropolitan Electric Supply Company has now power under its Mid-London Order to supply), the reason being that the former company's supply in its present areas is by continuous current, instead of alternating current, which was understood to be the system of the latter company. Since then the Highways Committee has received a letter from the County of London Company, stating that it is prepared to charge at a lower rate than the Charing Cross and Strand Company, and at the same time to supply alternating current by low tension for lighting purposes, and continuous current at 500 volts pressure for motive power. The Board of Trade having intimated its intention to hold an inquiry at which the parties interested should be represented, the chairman of the committee was requested to attend, and to state that, upon the understanding that the County of London Company's supply, if the order be granted, would be given in accordance with the above letter, the opposition of the Council to the granting of the order to the company would be withdrawn so far as related to the rates of charges and the supply by means of alternating current. It would thus be left to the Board of Trade to decide which of the two companies concerned should be allowed to supply the areas referred to in the respective orders. Arising out of questions on this matter, the chairman of the committee mentioned that at the inquiry in question, the Board of Trade decided that it was advisable to leave that area south of Oxford Street to the Charing Cross and Strand Company, and that on the north of Oxford Street to the County of London Company.

As will be seen from the following paragraph from the report of the Highways Committee, the County of London Company has been successful in its appeal to the Board of Trade on the much vexed question of transformer boxes.

The Committee reported:—The Council on December 7th last formally disapproved of the construction of four transformer boxes by the County of London and Brush Company, under its Northern Extension Order of 1897; and against this decision the company appealed to the Board of Trade. The Board gave its award on March 19th, allowing the appeal, and approving the construction of the transformer boxes, subject to the following conditions—(*a*) that the said transformer boxes be constructed in a manner precisely similar to the transformer boxes constructed within the area of the County of London (North) Electric Lighting Order, 1892; (*b*) that there shall be no gas pipe within such distance from any box as is equal in feet to the diameter of the gas pipe in inches. The company has since served a fresh notice, dated March 21st, 1898, of intention to construct the boxes referred to in the previous notice and sanctioned by the award, and has also submitted drawings showing the construction of the boxes as to be in accordance with the conditions attached to the award; and in the circumstances the Council can take no further action in the matter.

Manchester.—The Electricity Committee has adopted a report of its engineer recommending the extension of the Corporation electric lighting plant.

Mexico.—On 8th ult., according to the *Two Republics*, there was a failure in the electric light plant put down by Messrs. Siemens & Halske. It was said to be due to the derangement of the boiler, and of one of the dynamo brushes, and other causes.

Monmouth.—Complaints were made by members of the Council at the last meeting regarding the great delay that had arisen in the completion of the electric lighting installation. Alderman Tippins remarked that a year ago they were told the machinery was all ready, and, further, £1,000 was then paid on account. He also asked why was not the work of laying down the mains proceeding? The chairman's reply, as given in a Hereford paper, was: "I believe the answer is that the making of the turbines was let as a sub-contract, and some delay has been caused thereby."

Salisbury.—It is stated that the electric lighting works will probably be in a position to supply current about the middle of this month.

Southampton.—The electric lighting mains are to be extended down a number of roads. The electrical engineer reports the number of units registered during February, 1898, at 20,288, being an increase of 43 per cent. on that for February, 1897. Mains are to be laid in a number of additional thoroughfares.

West Ham.—Messrs. Ferranti have sent a long letter to the Council, in which they said that they could not undertake to have the engines and other machinery ready before June. The letter, which added that the engineering dispute had hampered them a great deal, was referred to the Highways Committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Anglesey.—It is suggested by the County Council that the electric line from Garth to Beaumaris should be on the sea or south side of the main road. The promoters proposed to lay it along the opposite side.

Bangor.—It is stated that a number of private gentlemen are setting an electric tramway scheme on foot, the line to run from the far end of the Bangor Pier to the railway station.

Bristol.—A few weeks ago in referring to the position of affairs between the Bristol City Council and the Tramway Company, who desire to go in extensively for electric traction, the word "deadlock" was used to describe the state of affairs. The accuracy of the term is shown by the voluminous report of the Sanitary Committee issued this week for the consideration of a meeting of the Council on April 1st. The document includes the correspondence between the committee and company. The committee, in their first letter of March 3rd, declared the committee would not assent to any arrangement which would involve any extension of the period at which the power to purchase any part of the undertaking would arise and insisted on the condition, No. 10 of their list, which said:—"The date at which the Corporation's power to purchase the power station and proposed extension would arise to be the same as for the present horse tramways." The committee further intimated they would not be able to recommend the adoption of the overhead wire system on some of the existing tramways. The company expressed, in their reply, astonishment at hearing the committee now objected to the overhead system on some lines. The company had no intention of adopting any other than the overhead system which was the only one accepted as practicable by all companies and municipalities in this country dealing with the subject. Insistance on No. 10 would preclude the possibility of further negotiations. In their next letter, of March 9th, the committee modified their position a little. They said: "The committee would be prepared, if all other questions with the company were arranged, to recommend the Council to assent to the use of the overhead system upon all the existing tramways and upon the extensions, on condition that if any other system of electric traction which might appear to the Council to be an improvement on the overhead system were adopted and worked at a profit of 5 per cent. or upwards on the capital employed in five or more towns in the United Kingdom with a population exceeding 50,000, the company would adopt that system on notice from the Council." They also asked if the company were willing the extensions should be constructed by the Corporation and leased to the company for a term of years expiring at the date when the civic power to purchase the horse tramways would arise, at a rent sufficient to cover the interest and annual instalment of the loan for defraying the cost of the work. The company declined both proposals, declared they were anxious to give to the public the benefits of the overhead system of electric traction, and suggested that failing agreement with the Corporation the settlement of a uniform period of purchase by the city be left to the Parliamentary Select Committee. They further suggested the Sanitary Committee might name a period at which all tramways existent in the city or which might be constructed, including so much of the Hanham Light Railway as might be in the city, should be purchasable. The committee in answering varied their condition with regard to calling on the company to alter the overhead system for one deemed preferable, chiefly, by making the towns referred to, have a population of over 100,000 instead of 50,000, and inserting the proviso that the civic demand should be subject to the Board of Trade, regarding it as equitable that the company should make the change. The committee declined to leave it to a Parliamentary Committee to fix a term at which the lines might be purchasable. The company accepted in principle the amended suggestion as to conditions on which they should be asked to change their system, but adhered to their previous determination in regard to condition No. 10 in the list. The horse lines, it should be explained, have about 14 years to run, and the Tramway Company want for the extensions the full 21 years allowed by the Tramway Act. The Sanitary Committee now recommend the Council not to agree to an extension of the period of purchase, and not to agree to a use of the overhead system throughout the tramways; further, that they be authorised to require the company to withdraw the Extension Bill when the Council think fit, and that the Committee be authorised to proceed with the opposition to the Electrical Powers Bill.

Charing Cross, Euston and Hampstead Railway.—The Unopposed Bill Committee of the House of Commons last week passed the Bill promoted by the Charing Cross, Euston and Hampstead Railway Company, which was incorporated in 1893 for the purpose of constructing an underground electric railway between the points named. By this Bill the company is authorised to extend its Charing Cross terminus from the Charing Cross Road to a point under Craven Street, Strand. The Bill also extends the time for constructing the authorised lines until August, 1902, which is two years beyond the time originally granted.

Chesterton.—The British Electric Traction submitted a plan of the proposed route of the Chesterton Tramway to the Parish Council last week for suggestions, and several alterations were proposed.

Christchurch and Poole.—The British Electric Traction Company has proposed a new scheme for electric tramway communication between Christchurch and Poole. The Christchurch Council will grant the Company an interview this month.

Clontarf.—On Saturday last a large number of gentlemen representing the local authorities, accepted the invitation of the Dublin United Tramways Company for the inaugural run to Clontarf and back on the electric system, which has just been completed between Nelson's Pillar and Dollymount. Four special cars were placed at the disposal of the guests.

Dublin.—On 22nd ult. Major Cardew inspected, on behalf of the Board of Trade, the electric tramway from Nelson's Pillar to Dollymount.

Dudley and District.—On Monday at the monthly meeting of the Stourbridge Urban District Council, a draft order of the Light Railways Commissioners with reference to the Dudley and District Light Railway was received, and the Council was asked to send any observations on the same to the Commissioners. The matter was referred to a committee.

Electric Traction for London.—Mr. Douglas Young, in a paper on "London Traffic Problems and their Solutions," read before the Auctioneers' Institute in London on Tuesday, referred to the subject of electric traction. He said that the "enterprising municipalities of Glasgow, Belfast, Leeds, Manchester, Liverpool, Sheffield, Huddersfield, and Birkenhead, to say nothing of many great Continental, American, and Colonial cities, had, after careful experiment or inquiries, arrived at the conclusion that the best discovered system of tramway was that known as the overhead electric system. The electricity was generated at a centre, and conducted along overhead wires, which were either carried from house to house or suspended on ornamental columns with arms. He had seen this system at work in Bristol, Rome, and Milan, and could say that, from an æsthetic point of view, little or nothing was to be urged against it, in fact the pillars or wires suspended from place to place were made to hold the electric lamps, and might be made an ornamental feature. The system was safe, rapid and elastic as to speed, clean, comfortable, and flexible enough to apply to all routes, and met all contingencies of street traffic under ordinary circumstances. It was supplanting all other systems, and in the farther suburbs the prospect of tramcars running in connection with a well-conceived circle system of underground electric railways, opened up a bright future for largely solving the problems of street traffic, and for the comfort and convenience of our people and city.

Fatality.—At Douglas on Thursday, an engineer named Cæsar Brew, employed by the Isle of Man Electric Tramways Company, was attempting to jump on an electric motor car when he slipped and fell on to the line. The car went over his head, almost severing it from the body, death being instantaneous.

Flamborough and Bridlington.—The Flamborough and Bridlington Light Railways Bill has received the formal assent of the Board of Trade in spite of the opposition of the local authority concerned. The work may be expected to be commenced shortly. Messrs. Siemens, Bros. & Co. and Messrs. Whittaker Bros. are the contractors for the electrical plant and the earth work, the civil engineer being Mr. Myers-Beswick, and the electrical engineer Mr. Bernard Drake. Apart from the passenger traffic, which is considerable during the season, the introduction of this line is expected to have an important bearing on the fishing industry of the North, for it is stated that frequently boats which cannot enter Grimsby, will deliver their fish under the shelter of Flamborough Head as soon as facilities for transport exist.

Glasgow.—At an early meeting of the Tramway Committee the proposal to work the new tramway line to be laid in High Street and Castle Street with electricity, in conjunction with the Springburn route, will come up for consideration. There will be sufficient car accommodation and electric power at the Keppochhill depôt to enable the extension to be worked with the Springburn section.

L.C.C. and Electric Traction.—When reporting in February upon the applications for electric lighting provisional orders this session, the Highways Committee expressed the opinion that a clause should be inserted in each order for the protection of the Council's interest in the tramways already purchased, and those to be acquired in the future. At the request of the Committee the following clause was prepared by the Parliamentary Committee:—"If and when the London County Council adopt or permit the use of electrical traction on any of the tramways of the Council, including tramways in any street in which electric lines have been laid down under this order, it shall be lawful for the Council to serve on the undertakers notice in writing requiring them to make such alterations in the position of their lines and works as may be required for adapting such tramway for the use of electric traction thereon, and the undertakers shall thereupon proceed with all reasonable despatch to effect such alteration or removal, at their own cost, and without having any claim against the Council for compensation. Provided that if any difference arises between the Council and the undertakers as to whether the required alterations are necessary for the purposes aforesaid, such questions shall be referred for determination to the Board of Trade, whose decision shall be final." The Highways Committee recommended that the Board of Trade should be requested to insert the above clause in those provisional orders which might be granted in the present or any future session. This recommendation was adopted, the Chairman promising, at the suggestion of Earl Russell, that the clause should be made clear to the Board of Trade to refer only to alterations from a mechanical point of view.

Liverpool.—Thirteen members of the Tramways Committee, accompanied by the Lord Mayor, left Liverpool on Friday afternoon last for Hamburg, to inquire into the working of the electric tramways of that city.

Middlesborough, Stockton and Thornaby.—In regard to this electric line a Middlesborough paper says that the work at the power houses and depôt at Stockton is now in a forward state. The machinery and plant is being rapidly laid down and all the arrangements completed and closed up against the time when the preliminary trials will have to be made.

Ostend.—The Société Anonyme des Railways Economiques de Liege Seraing et Extensions, and the Compagnie Générale des Railways à Voie Etroite of Belgium have just ordered, says *Daily Tenders and Contracts*, a complete electrical equipment from the Westinghouse Electric and Manufacturing Company for a storage battery system traction road in Ostend, Belgium, which promises to prove remarkably successful. The generating plant will consist of a 60 H.P. compound high pressure engine, connected with a Westinghouse multipolar dynamo of 38 kw. capacity, running at 600 revolutions a minute, and producing a current at 280 volts. The cars are to be equipped with a group of batteries and will be able to run 40 miles before recharging. A complete Westinghouse system, with switchboards will be placed in the generating station.

Power Distribution.—On 22nd ult., before the Institution of Engineers and Shipbuilders in Scotland, Glasgow, Mr. Henry Mavor contributed a paper on "Some of the Economic and Practical Aspects of Electrical Power Distribution in Factories." During the past few years, he said, there had been a decided awakening of interest in the possibilities of electrical distribution of power in factories. Long distance transmission of power was of less interest to us in this country because of our local conditions. In reference to the power scheme for the Midlands, he said that it seemed probable that the operation of such a scheme would only be commercially practicable in districts where the local authority does not control the electric supply, because, when the local authority has to be dealt with, the price obtainable from it would not exceed the rate at which it could itself produce the power without any allowance for profit. On the other hand, there was undoubtedly an enormous field for the electric motor among small users of power who could obtain the electric current at a moderate rate from supply companies or local authorities. The lecturer divided power consumers into various groups —(1) The case of factories, chiefly textile, where the power is delivered from one large engine from gearing or belting of machinery closely grouped round the source of power, such as spinning and weaving factories; (2) in the case where the nature of the work is such that the power must or ought to be delivered direct at the point where it is applied to the work. This included factories and works where the machines to be driven were widely divergent in character, were widely spaced, and run at different and varying loads and speeds, as in paper mills, print works, chemical works, steel works, foundries, shipyards and many engineering establishments where work of a varying character is to be accomplished. In the latter group the lecturer considered there is a very wide field for the application of electric power distribution in the Glasgow district.

South Staffordshire.—At a meeting of the Tipton Council on Tuesday, a letter was submitted from the Board of Trade enclosing a communication received from the South Staffordshire Tramways Company respecting the renewal of steam licenses, but it was stated by the chairman that the Council would not take any further action in the matter until an application was made for Parliamentary powers for the use of electric traction.

Stourbridge.—The Urban Council has received the draft order of the Light Railway Commissioners relative to the Dudley and District Light Railways. The Council was asked to consider the draft, and if it had any representation to make, to do so by April 7th. The order proposed to give the promoters three years to finish the work in, but a representative of the British Electric Traction Company stated that the existing tram line would be converted and the electric trams running in the present year. The draft order was referred to a committee.

The "Underground" and Electric Traction.—The Metropolitan Railway Bill, under which powers are sought to work the lines by electricity, was before a committee of the House of Commons on Monday. Mr. Littler, Q.C., opened the case for the promoters, and Mr. John Bell, the chairman of the Company, gave evidence in support of the Bill. The Great Western Railway Company appeared in opposition, and with respect to this, Mr. Freeman, Q.C., speaking on behalf of the promoters said:—"I may say that under the Bill as drawn, if the Metropolitan Company satisfy themselves that electric traction is the proper power to use on the railway we shall require the Great Western to alter their engines to suit the new conditions. Their engines would be under our control, but if they objected they would then have power under previous agreements to take us to arbitration." Mr. John Bell stated that if the Metropolitan had to make an enormous change for the benefit of the public he did not see that the Great Western would have any ground of complaint if they were compelled to do the same with regard to the few trains that run over the system in the course of the day. If the electric traction is the success they expected it would be they would not extend the electric traffic to Aylesbury. They did not propose to go further with it than Swiss Cottage. Sir John Wolff Barry, engineer to the company, and Sir Benjamin Baker, gave evidence for the promoters on the engineering aspect of the scheme.

The committee sat again on Tuesday to consider the Bill. Mr. Pember, Q.C., for the Great Western Company, briefly addressed the committee, contending that, if his clients were forced to adopt electric traction, they should be compensated for the extra expense involved in the provision of electric engines and rolling stock. He submitted for insertion in the Bill a clause drawn up by the petitioners to the effect that nothing in the measure should prejudice the working of agreements already in existence, and that questions as to the method of carrying out the proposed change should be referred to arbitration as well as any alterations that might be necessary in Great Western engines and rolling stock, and any alterations in working, and also the question of cost. Mr. Freeman, Q.C., replying for the promoters, said the company were proposing to incur this great expense simply and solely to improve the conditions of working the traffic. The Great Western Company, who were virtually partners in the railway, would be equally benefited so far as their traffic over the line was concerned. His company were prepared to safeguard all the rights of the Great Western Railway Company, and to do this his company would consent to the inclusion in the Bill of a clause providing that, should the Metropolitan Company at any time require the Great Western to substitute electric traction for steam locomotion on any of the trains of the Great Western Company working over the Metropolitan Railway, either of the companies should be entitled to refer such requirement to arbitration as if the same had been included under the terms of the existing agreement. He submitted that it was unreasonable to expect that the Metropolitan Company should pay the expense of converting the rolling stock of the Great Western if, under the pressure of public opinion, it became necessary for that company to follow the example of the Metropolitan Company and use electricity. The chairman asked if the petitioners doubted whether electricity would ever be used on the railway. Mr. Worsley Taylor said they acknowledged that electricity might be useful, but were of opinion that to adopt it might involve great changes in the rolling stock, and that before they were called upon to pay for the change the subject should be threshed out before an arbitrator. After some further conversation, the chairman said there was no opposition to the suggestion that sooner or later electricity would have to be used on the Metropolitan Railway, and, as the Great Western Company were to a great extent parties to the working of the railway, the committee felt that in making the great change which was not contemplated in 1869, there should be some special clause introduced into the agreement. Time was allowed to the parties to prepare a clause. In the course of the proceedings the chairman said that the committee were satisfied that there was every prospect of electric traction being used on the railway. The committee sat again on Wednesday and adjourned.

Waterloo and City Railway.—It is stated by a morning contemporary that there is talk of running the first train over this line on Monday, May 2nd.

Whitley.—A public meeting, on 24th ult., approved of the proposal of the British Electric Traction Company to establish an electric tramway from Cullercoats through Whitley, and suggested that it be carried on to the sea front at Monkseaton Lane. Mr. Frank B. Lea explained the scheme. The opposition was weak as water, but it was certainly novel, for a Mr. Saint "expressed the fear that the introduction of tramways into the district would give facilities to persons to travel more easily beyond the three miles limit on a Sunday to obtain drink. He also regarded the trams as a danger to children."

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable Obidos-Manaos ...	March 9th, 1898 ...	March 26th, 1898
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Gibraltar-Tangier	March 19th, 1898 ...	March 28th, 1898
Lourenco Marques-Durban...	March 19th, 1898 .	March 25th, 1898
Havre-Waterville ...	March 28th, 1898 ...	...
Odessa-Constantinople ...	March 28th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...

The Telephone Service.—According to Wednesday's *Standard*, Mr. Faithfull Begg proposes to bring forward an amendment to Mr. Caldwell's resolution with regard to the telephone system which will be moved on going into Committee of Supply on the Civil Service estimates to-night (Friday). The amendment is to the effect that the acquisition by the State of the whole telephone system of the country is the only solution of the difficulties which exist, and are increasing under the present system of licences. The amendment can only come on in case Mr. Caldwell's resolution is carried.

(*Continued on page* 447.)

TORQUAY MUNICIPAL ELECTRICITY WORKS.

As we briefly announced last week, the municipal electricity works were formally opened on March 17th.

The municipal authority of Torquay obtained powers to undertake a public supply of electricity as far back as 1891; but it was not until 1896, when there was some danger of the provisional order being revoked, that the Corporation really determined to erect electricity works. Mr. Trentham, who had previously prepared reports on the subject, was entrusted to prepare a plan and specifications, which were adopted by the Council, and have since been carried out.

The system that has been adopted in Torquay is a high pressure alternating current supply; the pressure at the consumers terminals being 200 volts, the street lighting being done by means of arc lamps using rectified currents. An unusual feature about the works is, that, subject to modifications, a building was ready to hand in the shape of large and lofty coal cellars owned by the Corporation. The cellars can scarcely be said to be underground, being, as a matter of fact, formed from excavations made under a high level road, entrance to them being from a low level road adjoining the harbour. Although provided with four walls for housing the generating plant, it was necessary to carry out important alterations to adapt the cellars for electric lighting purposes. For instance, it has been necessary to excavate for the purpose of making foundations for the machinery. This operation entailed the removal of 300 tons of limestone rock, which had, for the most part, to be blasted. The machinery now rests upon a solid block of concrete, which is isolated from the adjoining walls by means of hair felt. It was discovered, at the conclusion of the excavations, that at times of very high tide sea water percolated through the walls, and to avoid this the lower part of the excavations has been concreted. An ordinary wide road divides the works from the harbour, and this contiguity to the sea provides facilities for obtaining sea-borne coal; moreover, it gives an abundant supply of water for condensing purposes.

"Where's the chimney?" was propounded as a sort of conundrum on the opening day, and certainly, to one who is accustomed to look upon a tall chimney as a guide to electricity works the matter was slightly perplexing. As a matter of fact, the chimney shaft passes up through an adjoining building, owned by the Corporation and utilised for concerts and entertainments, the top of the chimney being no higher than the roof of the building. In consequence of the chimney being restricted to a height of 60 feet, forced draught has been resorted to.

The internal appearance of the dynamo room by no means suggests anything of the cellar; the room is lofty, of a considerable size, and is well lighted. An excellent idea of the arrangement of plant will be obtained from the general view of this room. The boilers are placed in an adjoining room, which has been permitted to retain much of its underground attributes.

Laying the Mains.

Coming to the more prosaic details of plant, we will begin with the boilers, of which there are three, each having 1,619 square feet of heating surface, and 30 square feet of grate area. Each boiler is composed of eight sections of tubes, each tube being 18 feet long.

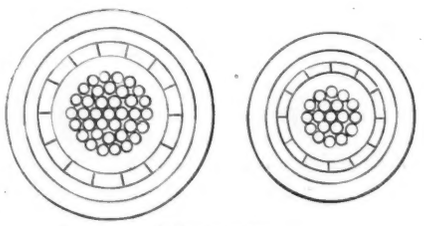
The horizontal steam and water drum is 3 feet 6 inches in diameter and 22 feet 7 inches long. Each boiler is complete with the usual fittings, including Hopkinson's safety valve, stop valve, blow-off valve, &c. The fact has been mentioned that forced draught is necessary, and each boiler is, therefore, fitted with steam blowers for forced draught. In addition there is a Babcock & Wilcox patent superheater, having 226 square feet of heating surface, and consisting of 32 drawn steel tubes 1½ inch in diameter, connected at the ends to a wrought steel cross box, the tubes being fastened therein by expansion. The upper cross box is connected to the steam and water drum by two 4-inch steel tubes

expanded into a nozzle provided for the purpose, and at the upper end of these tubes there is a cast-iron dry pipe. Prevention against overheating during the time of raising steam is insured by the arrangement for flooding the superheater, and using the superheater then as part of the heating surface of the boiler, although if the flooding is omitted, when raising steam, damage is not likely to result if the fire is not forced too rapidly.

In conjunction with the steam raising plant there is the inevitable Green's economiser, which is made up of 192 pipes, and fitted with the usual safety valves, thermometer, scrapers, &c.

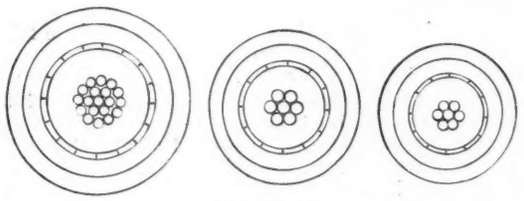
In a triangular apartment between the engine room and the boiler cellar are the pumps for feeding the boilers and for the condensing water.

The boilers are fed by two Worthington duplex feed pumps, each having a steam cylinder 5¼ inches diameter and a water cylinder 3½ inches diameter, the length of stroke being 5 inches.



L.T. concentric.
37/14 S.W.G. section ·1906. 19/14 S.W.G. section ·0976

Before passing on to consider the other plant, it may be mentioned that, though no detailed tests have yet been made to show the effect of the superheater, the steam is apparently very dry, there being, as a rule, no water deposited in the separators. The fuel at present used is a mixture of three parts of coke to one of Welsh coal, the price of the former being 12s. and of the latter 20s.



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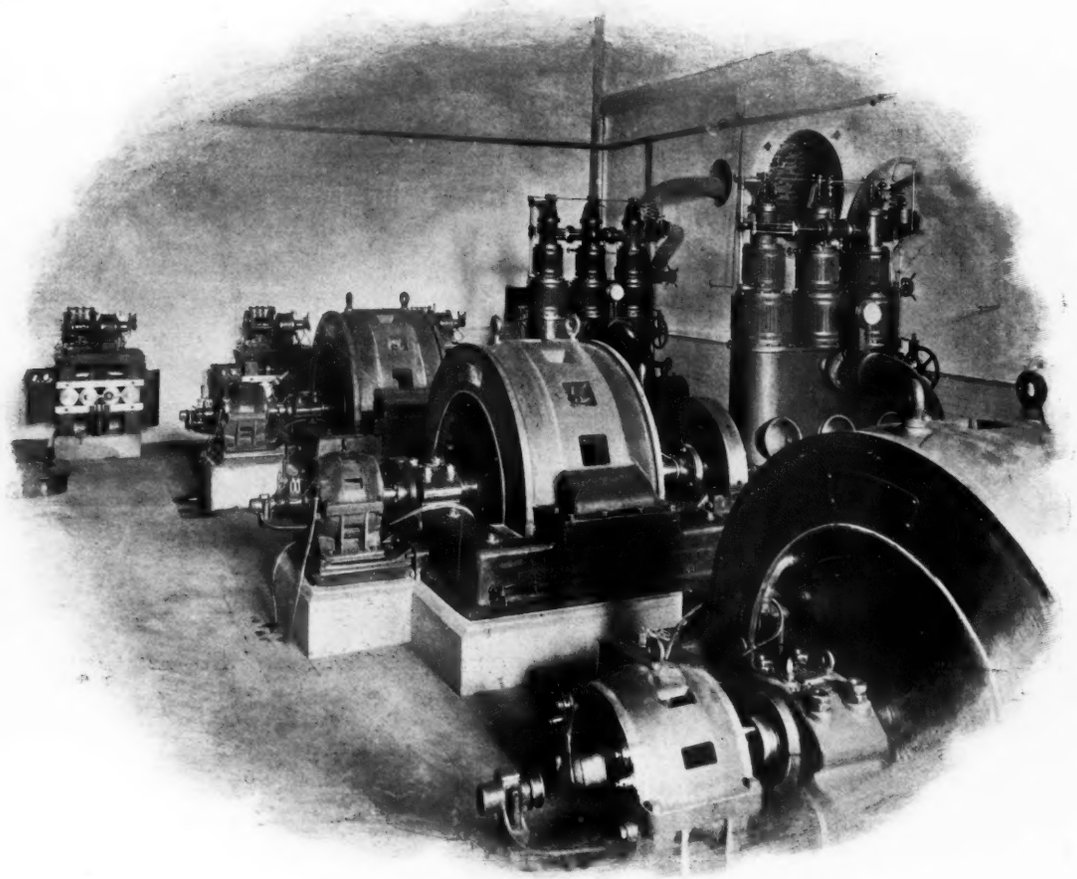
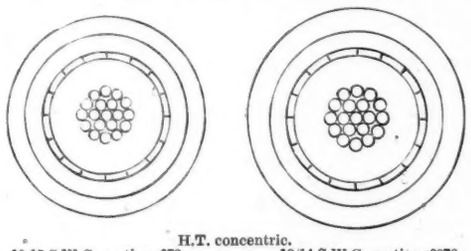


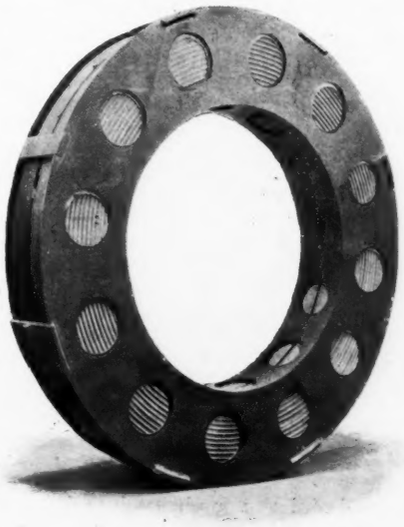
Engines and Dynamos.

We have already referred to the interior of the dynamo room. The plant at present erected consists of three Willans engines direct coupled to Fynn alternators made by Messrs. Easton, Anderson & Goolden. The engines are of Willans three-crank compound condensing type working at a steam pressure of 130 lbs., and developing 200 B.H.P. The alter-



H.T. concentric.
19/15 S.W.G. section ·079. 19/14 S.W.G. section ·0976

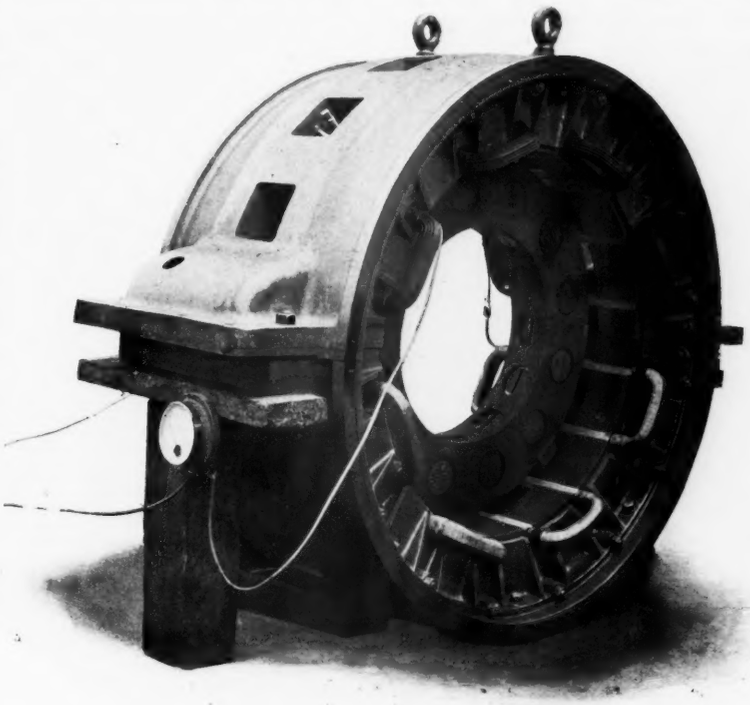
nators, to which we have not had previously an opportunity of referring, are of the inductor type, running at 380 revolutions and having a ~ of 50. The armature forming the outer frame of the machine, the field magnets (the revolving part) being mounted on the main shaft of the alternator.



Field Coil of Fynn Alternator.

There are eight armature coils in each machine, which are wound with stranded double cotton-covered cable. The coils are laid in paper tubes, and laid in slots in the laminations. Inside the armature frame is placed the field magnet coil, which is supported on brackets, this being shown in one of the illustrations. The field magnet coil occupies a position in the completed machine, between the poles of the revolving field magnets. It will be observed from the illustrations that the two circles of pole pieces are so arranged, that the poles in one circle are opposite the gaps in the other circle. The inside diameter of the armature is 4 feet 6 inches, and the width is 40 inches.

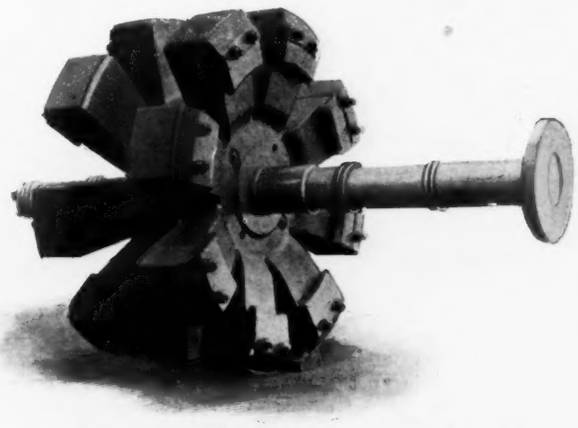
The alternators have been specially designed for noiseless running, there being a stringent condition in the specification compelling the contractor to remove the machinery to another site in the event of its being sufficiently noisy to create a nuisance.



Armature and Field Coil of Fynn Alternator.

The street lighting, as we have observed before, is done by means of rectified currents. For this purpose three Ferranti rectifiers are employed. They do not differ materially as far as constructional detail is concerned with those in use at Hammersmith, which were described in these columns.

In the constant current converter, the moveable coils are supported on toothed wheels which gear into a rack. On the top of the constant current converters is mounted a base plate carrying the alternating current motor, and on the end of the shafting of the alternating current motor is arranged the high tension commutator with its rocker and brushes complete. At one side of the constant current converter is attached the two-unit converter required for running the alternating current motor, and on the other side is attached the water break switch which is connected in series with the arc lamps.



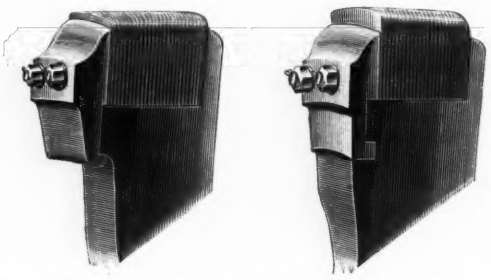
Field Magnets of Fynn Alternator.

The switchboard is similar in construction to the now well known type of Ferranti switchboard, the board being composed of slatework partitions, so as to be thoroughly fireproof throughout. Each partition forms a separate dynamo, or circuit panel, each one being provided with a special spring break switch.

Each panel is provided with a duplicate set of fuse contacts and oil break fuses, the arrangements enabling any fuse to be withdrawn and examined whenever desired without interfering with the working of the circuit. On each panel is arranged a vertical scale ammeter. The bus bar is arranged on the ring main system, enabling any circuit to be isolated and the remainder of the circuits to be run without interference. The usual synchronising arrangements are provided. Low tension gear is also attached to this board and is arranged so that it is brought into the 6-inch centres occupied by the high tension panels above it. The resistances are arranged in small resistance boxes, with hand regulator and ammeters on the top, thus placing the whole of the high tension and low tension gear in one straight line, and enabling the attendant to attend to both at one time.

The arc light switchboard, which is placed near to the rectifiers, is arranged for controlling three rectifiers and

the respective circuits; it is, however, arranged to enable any new rectifier to be connected at once on to any circuit or any rectifiers running any number of circuits together. It is provided with a plug box on the bottom of the board, which plug box receives the current from main board and distributes it to each rectifier through an independent fuse. The plugging arrangement of this board is noteworthy, the plugs being attached to flexible cords and weighted with a



Showing Methods of Fixing Pole Pieces in Fynn Alternator.

pulley, so that when not in use they are kept in a fixed position. Each circuit is provided with an ammeter and pole indicator. A voltmeter is arranged with a plug and a pair of flexible cords, plug sockets being fixed for each circuit panel, so as to enable one to ascertain the voltage of any circuit.

The outside work reveals nothing that can be considered very novel. The low pressure distribution is accomplished from scattered transformers placed in the roadway. The street lamps are not placed on alternate mains, but one main feeds the whole of the lamps in one part of the town and other mains supply current to other sections.

The transformers are of the Berry type, and have been made by Messrs. Nalder & Harrison. The sizes are 30 kw., 20 kw., and 10 kw. In most cases they are placed in sheet steel cases, which are in turn placed in cast-iron road boxes, which have separate spaces for the high and low tension switches and fuses.

We illustrate some of the sections of the mains in use which have been laid by the British Insulated Wire Company.

Some of the high tension cables are laid in Doulton conduit, and some are laid in wooden troughs filled in with a hard-setting compound. The low tension cables are double steel armoured, and laid direct in the ground.

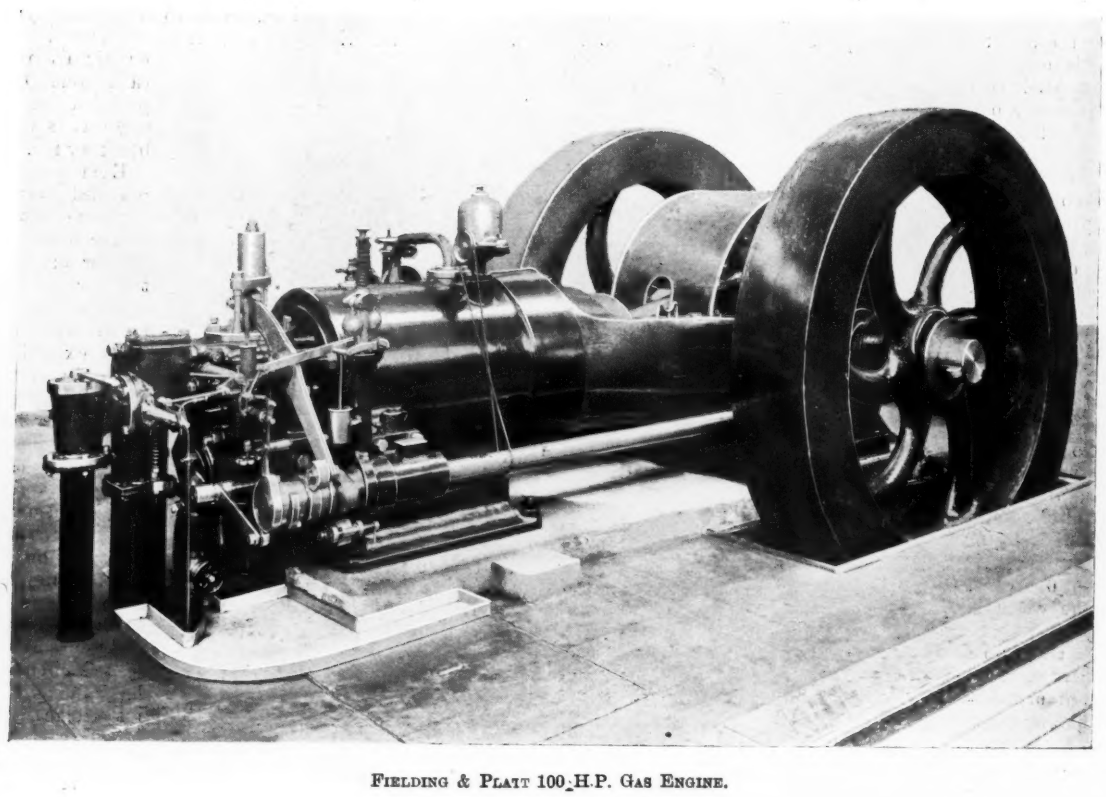
The arc lamp columns (which are supplied with overhanging brackets) have been supplied by Messrs. James Allen, sen. & Sons, of Glasgow, and the arc lamps are of the Crompton-Pochin type.

The demand indicator system is in use, and at the opening ceremony 3,600 8-C.P. lamps had been connected, which augurs well for the future prosperity of the works.

The principal contractors are as follows:—Boilers, Messrs. Babcock & Wilcox; engines and alternators, Messrs. Easton, Anderson & Co.; cables and street work, British Insulated Wire Company; switchboard, Messrs. Ferranti, Limited; transformers, Messrs. Nalder & Hilton; crane, Messrs. Isles, Limited. Mr. Trentham, the consulting engineer, is to be congratulated upon bringing the lighting of Torquay to a successful issue in the face of much opposition and difficulty.

100 H.P. GAS ENGINE.

It cannot be denied that much has been done during the past few years to develop gas engines for electric lighting. One of the latest types that has been specially designed by Messrs. Fielding & Platt for the driving of dynamos is one of 100 H.P., which was exhibited at the Brussels Exhibition, an illustration of which is given here. As far as we can learn, the cyclical variation in this engine does not exceed ½ volt. This result is obtained by having an impulse at each cycle, no matter what the load may be, from no load to full load. The method in which this is carried out is very satisfactory, so that, even when running absolutely light, the charge is stated to be fired with the greatest certainty.



Fielding & Platt 100 H.P. Gas Engine.

The cylinder has a diameter of 20 inches, with a stroke of 27 inches, the crankshaft being 8 inches in diameter in the main body, whilst the crankpin is 11 inches in diameter, the main bearings being 14 inches in length, and the crankpin 10 inches. The crank is balanced by a pair of counter-

weights strapped to the crank throws, and continuous lubrication of the crankpin is provided for by an annular oil channel, into which the oil is dropped from a fixed sight-feed lubricator. The engine was designed for driving two dynamos, one from each fly-wheel, the latter weighing about 5 tons each.

The engine is fitted with Fielding's self-starter, the action of which is as follows: The crank being placed at an angle of about 15° above the near dead centre, gas is admitted to the combustion space, and an outlet opened near the flame of the Bunsen burner, which heats the ignition tube; this outlet permits of the escape of air as the gas enters. As soon as the gas begins to escape along with the air, a blue flame is formed; and as the proportion of gas to air increases, the colour of the flame gradually changes to a yellow luminous flame. As soon as the flame indicates that the escape is practically all gas, the outlet is closed, and the gas shut off. All that is required now to start the engine is to admit compressed air, which, entering the clearance space, rapidly mixes with the gas, forming a highly explosive compound under a pressure of usually about 60 lbs. per square inch.

Before sufficient air can obtain admittance to form an actively explosive mixture, the piston is put slightly into motion for a short distance until the explosion takes place, whereupon the motion of the piston is greatly accelerated, and the engine is put into action with sufficient force to enable the ordinary cycle to follow on.

The compressed air is stored up by the engine itself into a small reservoir, the energy stored up in the fly-wheels serving for this purpose, the gas for the moment being cut off, and when required, a separate charging pump is fitted, worked either by hand or by power, but as a rule this is unnecessary.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 442.)

The Bolinao Cable.—A telegram in the daily press, dated Singapore, March 23rd, stated that the telegraph steamer, *Sherard Osborn*, was leaving there for the Philippines for the purpose of transferring the Bolinao cable to Manila. The transfer will be permanent.

Direct Cable to Cuba.—The following is a translation of an article appearing in *El Imparcial re* the above cable:—"The Ministry of the Interior has reported favourably on the tender for the laying of a direct cable between the Peninsula and the island of Cuba. The cable will land at Cadiz, Santa Cruz de Tenerife, Nieques (an island situated 15 kilometres to the east of Porto Rico), and finally, at Havana. The cable will not, contrary to the interest of the nation, be laid to St. John, Porto Rico, as the company owning and working the cables in the lesser Antilles have exclusive landing rights for 40 years at that island, and for this reason neither the Government or any private company can establish telegraphic communication which they may consider necessary. The report has already been passed on by the Minister of the Interior to the Minister for the Colonies for the embodiment of Government rights and privileges, and the decree calling for tenders for the laying of the cable will soon appear." Another paragraph states:—"The Minister of the Interior had an interview with the Minister of the Colonies for the purpose of preparing the report asked for by the Council of Ministers on the cable between the Peninsula and Cuba. The report will deal with two proposals, one being for the construction of the direct cable, and the other for a branch cable from Havana to Hayti to connect there with the French system."

Another issue of the same paper states:—"The news that the Ministers of the Colonies and the Interior have been entrusted by their colleagues in the council with the decision regarding the matter of the direct cable to Cuba, and, further, that there are two proposals to be dealt with, viz, (1) offering to construct a direct cable, and (2) a branch cable from Havana to Hayti, there to be connected to the French system, has given rise to certain fears, which we find to have serious foundations, as by the latter scheme we should merely be ridding ourselves of the control of our communications by Great Britain and the United States to transfer it to the French. The *Nacional* states if the direct cable is not to be laid, rather than allow all the traffic to be handed to the French Cable Company, let the state of affairs remain as at present. Our contemporary asks for more light upon the subject from the Ministerial press, and we join in the demand, as we endorse their opinion."

Glasgow Telephone Service.—On 24th ult., the Corporation deputation had a private interview with the Postmaster-General, at Norfolk House, on the subject of granting a municipal telephone license for Glasgow. Various points were enlarged upon by the deputation, and the Duke expressed his desire to act impartially. He asked if the granting of a license conditionally might not be held to prejudice any opposition. The deputation replied that they were perfectly willing that the granting of a conditional license should be so safeguarded and hedged in as to leave most unfettered discretion to Parliament in dealing with the Corporation's proposals. In the course of the conversation the deputation repeated the decision of the Town Council under no circumstances to grant the telephone company the right to utilise the streets. The Duke of Norfolk assured the deputation that he thoroughly understood the position, that he would give it his careful consideration, and that he would communicate with them shortly.

Secrecy of Telegrams.—We understand that on 22nd ult. a notice was issued by the Postmaster-General to the postal staff, calling attention to a question recently addressed to the Secretary to the Treasury in the House of Commons upon the subject of the secrecy of telegrams. The construction of private apartments in postal telegraph offices was advocated as a means of greater privacy being secured to the public while handing in telegrams. The Postmaster-General enjoins the counter clerks to deal with telegrams in such a manner as to preclude them being read by the public.

The Telephone Service.—About 20 members of Parliament, under the presidency of Mr. Provand, met at the House of Commons on 24th ult., and decided to put down a motion in favour of the Post Office granting licenses to local authorities to work telephones of their own.

In the Commons on 22nd ult., Sir M. Stewart asked the Secretary to the Treasury, as representing the Postmaster-General, whether any judicial decision has ever been given that a telephone instrument is equivalent to a telegraph except as regards the Postmaster-General's monopoly of the right of conveying messages by wire.

Mr. Hanbury, in reply, said the decision that a telephone is a telegraph was given by the Exchequer decree of the High Court of Justice in the case of the Attorney-General *v.* the Edison Telephone Company. This case arose on the right of the Postmaster-General to a monopoly to conveyance of messages by wire. The exact words of the judgment, "For all these reasons we hold that the telephone is a telegraph within the meaning of the Acts of 1869 and 1863," are very wide.

A sub-committee of the Hull Corporation has been going into the question of the telephone charges and service generally, with the National Company's officials.

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington. — April 19th. The Corporation wants tenders for the supply and erection of three sets of steam dynamos, each set consisting of a triple expansion condensing steam engine of the inverted vertical type, 90 I.H.P., and of a shunt wound dynamo. Also a feed water heater, storage battery having a capacity of 750 ampere-hours, switchboard instruments, apparatus cables, wires, street boxes, connections, &c. For further particulars see our "Official Notices" this week. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Ashton-under-Lyne. — April 5th. The Corporation invites tenders from firms willing to undertake the free wiring of premises in the Borough. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices" March 25th.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" March 18th.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our 'Official Notices" March 18th.

Derby.—April 11th. The School Board want tenders for the electric wiring of the Traffic Street Board School, Derby. Particulars from Mr. J. E. Stewart, Corporation electrical engineer. See our "Official Notices" March 25th.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices" March 18th.

Manchester.—April 4th. The Lancashire and Yorkshire Railway Company is inviting tenders for various stores. The following are a few of the items:—5. Copper; 7. Copper tubes for boilers; 8. Copper tubing; 29. Signal and telegraph fittings; 30. Signal, telegraph and electric light wires. Samples may be seen and forms of tender and further particulars obtained at the Stores Department, Osborne Street, Manchester.

Shoreditch.—April 12th. The Vestry wants tenders for the supply and erection of arc lamps and accessories, also for electric light cable. Electrical engineer, Mr. C. N. Russell. See our "Official Notices" March 25th.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED

West Ham.—The Town Council has accepted the tender of Messrs. H. J. Rogers & Co. (£712) for wiring the public buildings for electric lighting. The Council hopes to be able to supply electricity to consumers in September next.

FORTHCOMING EVENTS.

1898.

Friday, April 1st, 8 p.m.—Institution of Junior Engineers at the Westminster Palace Hotel. Paper on "Mechanical Refrigeration," by Mr. J. T. Burrell, of Peterborough.

Royal Institution. Lecture by Prof. Dewar on "Liquid Air as an Analytic Agent."

Saturday, April 2nd, 11 a.m.—Visit of the Institution of Junior Engineers to the Thames Iron Works, Blackwall.

Tuesday, April 5th, at 8 p.m.—Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Paper by Mr. James Wimshurst upon "The Influence Machine and its Advantages for lighting X-Ray Tubes."

At 8 p.m.—The Institution of Civil Engineers. Paper to be read (time permitting) on "The Electricity Supply of London," by A. H. Preece, Assoc.M.Inst C.E.

NOTES.

In Honour of M. Gramme.—By royal decree on December 30th last, M. G. Gramme was nominated Commander of the Order of Leopold. On this occasion the international jury of the electrical sections of the Brussels Exhibition of 1897 decided unanimously to organise at Brussels a demonstration in honour of the celebrated Belgian electrician, and to celebrate his admission into the Order of Leopold by a banquet, to which electricians of all countries should be invited. The date of this celebration was fixed for March 27th, and it was to be commemorated by a medal, two impressions of which were to be struck, one in gold, and one in silver, to be forwarded to M. Gramme on the day of the banquet. Senator Montefiore Levi, founder of the Electro-technical Institute of Liège, honorary president of the Belgian Society of Electricians, and of the Association of Engineers from the Montefiore Institute, accepted the post of honorary president of the committee formed for the organisation of the demonstration, M. Mascart being the acting president. The subscriptions were received by M. Alfred Roosen, secretary of the organisation committee, Rue Vould, 64, Brussels.

Our Torquay Photographs.—The views of the central station and the operation of laying the mains given in our article on the "Electric Lighting of Torquay," have been prepared from photographs taken by J. C. Dinham, Torquay.

A New Departure in Incandescent Lamps.—Prof. Nernst, the well-known electro-chemist, has recently been experimenting with the view of discovering a better filament for the glow lamp, and has produced a lamp which is decidedly more efficient than the present filament. It remains to be seen whether the new filament will be more durable. According to recent theories of electrolysis, all electrolytes are more or less dissociated when dissolved in water, and it is these dissociated molecules which carry an electric current through the electrolyte. If none of the molecules of the electrolyte have been dissociated, no current will pass, except the E.M.F. of the current is exceedingly high. Dissociation of the molecules of electrolytes may also be brought about by heating them to a high temperature, and they become conductors of electricity in the same way as when they are dissociated by solution. It is this fact that has been utilised by Nernst in the construction of his new electric lamp. A thin rod of magnesium oxide, calcium oxide, or such like compound, is heated, in the first place, by a Bunsen burner to a red heat, and an electric current is then passed through it. If this current is sufficiently strong to develop enough heat to replace that which is given off, then, when the Bunsen burner is withdrawn, the current will maintain the rod at a white heat. A practical objection to this lamp is the preliminary heating; such lamps would, in fact, have to be lighted like the old-fashioned gas or paraffin lamps. The ingenuity of inventors may, however, yet overcome this difficulty. Since the temperature of ignition of the lamp depends on the electrolyte which is used, it is important to know which of these substances become conducting at the lowest temperature. With rods of equal dimensions, calcium oxide requires the oxyhydrogen blowpipe to bring it to the required temperature, while it is possible to start magnesium oxide by heating with a Bunsen flame. Nernst uses in his lamps magnesium oxide, which can be bought in the form of rods, and he recommends that the lamp should be ignited by the discharge of an induction coil. The ignition by the induction coil is not likely to be used in practice. Another method which has been proposed [*Zeit. f. Elek.*, Vol. 16, p. 103] is to embed a carbon filament in the magnesium oxide or other electrolyte made use of. When the rod is cold, the carbon filament will form a path for the current, and gradually communicate sufficient heat to the surrounding electrolyte to raise it to the conducting temperature. Platinum could not be used instead of the carbon, because it would fuse at the very high temperature developed in the Nernst lamp; and besides, all metallic threads would shunt too large a fraction of the electric current past the electrolyte. The efficiency of these Nernst lamps has been found to be extremely high, about 1·1 watts per candle-power; and it is estimated that in a vacuum the candle-power would be obtained with 0·7 to 0·8 watt. The life of such lamps as have been tried has not been very long. If it be true that electrolysis is taking place in the incandescent oxide, we should expect that the ions would accumulate at the ends of the rod; and if such were the case, it would not be favourable to the longevity of the lamp.

The Treatment of Battery Slimes.—An electrolytic process is now being worked in South Africa by the Crown Reef Gold Mining Company, for treating battery slimes, and thus removing gold which would otherwise be lost. The process seems to be working very successfully, if we accept the data given by J. R. Williams in the *Transactions* of the Chemical and Metallurgical Society of South Africa, 1897, July, pages 14 to 18. In this paper the results of two months' working are given, during which 6,640 tons of slime were treated with an assay value of 5·82 dwt., yielding 1,067 ozs. of gold with an actual extraction of 60·48 per cent., and giving a profit of £3,058. The cost of treatment per ton is 3s. 9·05d., in which we note that 0·40d. is included for electric light, and 2·75d. for power. After successive periods of treatment of three hours each, by electrolytic precipitation, a solution containing 2 drw. 12 grains of gold per ton assayed 1 dwt. 4 grains, 20, 12, 8, 4, 2 and 0·5 grains; whilst, after 24 hours, only a trace of gold was left.

Society of Arts.—On Wednesday evening Prof. S. P. Thompson read a paper before this society on "Telegraphy Across Space."

Telegraphing Without Wires.—The system of "telegraphing without wires," that is without *direct* wires between the two stations to be in telegraphic communication, recently suggested and experimented upon with so much success by Mr. Preece, Engineer-in-chief to the Post Office, has just been successfully applied to permanently establish telegraphic communication for the War Office between Lavernock Fort and the fort on the Flat Holm (in the Bristol Channel), a distance of 3¾ miles. On the mainland opposite the island, an ordinary pole line, three-quarters of a mile long, with a heavy copper wire, has been erected; the ends of the circuit terminates in the sea. On the island there is a similar line established, about half-a-mile long. The transmitting apparatus (on each line) consists of a contact breaker worked by a small dynamo, running at 3,000 revolutions per minute, and giving 250 makes and breaks per second, corresponding to the middle C note; the intermittent current is given by 10 Obach dry cells. An ordinary Morse key interrupts the circuit, and the receiving apparatus is an ordinary telephone receiver. The installation has been carried out under the direction of Mr. Gavey, Assistant Engineer-in-chief to the Post Office, assisted by Mr. Taylor. It has been found impracticable to maintain communication between the two forts by means of a cable, as the latter was continually broken by the anchors of the shipping.

Riveting by Electricity.—On Wednesday, before the Institution of Naval Architects in London, a paper on this subject was read by Mr. Holmes (secretary) for the author, Herr F. von Kodolitsch. The experiments of the author had extended over two years, and he had succeeded in bringing out a type of riveting machine quite capable of superseding the two systems already existing, namely, hydraulic and pneumatic riveting. There was no difference in the quality of the work done, but the quantity by the electric system was considerably superior. The machine he was describing closed 1,200 rivets in a day of 10 hours, when operated by three men and a boy. Specimens of the work done were exhibited. Mr. Hammond called attention to the fact that to use the electric riveter it was necessary first of all to lay down all the requisite electric plant. Mr. A. Denny stated that with the usual day and hydraulic machinery from 1,000 to 1,100 rivets could be closed, and he knew of one gang, where everything was arranged, which closed 1,500 rivets in the day. He thought that the use of electricity was bound to be economically applied in the building of ships at no distant date. Mr. C. Dutton thought the machine described by the author was not so portable as had been claimed. Our readers will remember that in the Electrical Review for October 30th, 1896, we described and illustrated several applications of Herr Kodolitsch's universal electric drill in the arsenal of the Austrian Lloyd's Steam Navigation Company.

Hull Electrical Exhibition, 1898.—We have received a prospectus giving full details of the Electrical and Industrial Exhibition, which it is proposed to hold from May 19th to June 4th, at the Assembly Rooms and Lecture Hall, Hull. The principal objects of the exhibition are those connected with the electrical development in lighting, transmission of power, telephones, and the economical application of electrical energy to practical work, and in view of the extension of the municipal electricity undertaking, the present is considered an opportune moment for such an exhibition. Diplomas of honour, and gold, silver and bronze medals, will be awarded to deserving exhibits, and for this purpose a number of well-known gentlemen have consented to act as jurors and referees. These include Sir Frederick Bramwell, Sir Douglas Galton, Prof. Fleming, Prof. Ayrton, and Messrs. C. Bright, H. Graham Harris, W. P. J. Fawcus, S. V. Clirehugh, W. C. Johnson, Shelford Bidwell, E. H. Crapper, S. H. Valentine, and Mr. A. S. Barnard, the Hull Corporation electrical engineer. Early applications for space should be made to Mr. Joseph Davis, manager, 3, Assembly Rooms, Hull.

Marriage.—By last mail we learn that Mr. W. Elsdon-Dew, electrical engineer, Pilgrim's Rest, Transvaal, was, on February 26th, married to Miss Jessie H. G. Rankin, eldest daughter of John Rankin, Esq., Australia.

Magnetism and Diamagnetism.—At the Royal Institution on Thursday last week, Prof. J. A. Fleming gave the fourth lecture of his course on "Recent Researches in Magnetism and Diamagnetism." Resuming the study of the properties of diamagnetic bodies, the lecturer showed, says the *Times* report, two experiments illustrating some of the remarkable properties of bismuth. Righi found that a bismuth wire placed in a magnetic field, and transversely magnetised, suffered a great increase in its electrical resistance, and Profs. Dewar and Fleming proved this effect to be enormously augmented at very low temperatures. Another peculiarity of bismuth was its marked exhibition of the "Hall effect." If an electric current was sent through a bismuth plate which was transversely magnetised, an electromotive force was brought into existence at right angles to the direction of the current and the magnetic field, and showed itself by causing a displacement in the equipotential lines. This effect occurred to some extent in all metals, but was several thousand times greater in bismuth than in any other case. Passing on to consider the relations between magnetism and heat, the lecturer first performed an experiment which rendered evident the effect of change of temperature on permanent magnets. A permanent steel magnet suddenly heated first lost a certain portion of its magnetic strength, and then reached a more stable condition, in which it was said to be "aged," a result which could also be attained by plunging the magnet into liquid air. After the permanent state had been reached, the effects of change of temperature became more regular, and recent research had demonstrated that certain kinds of steel could be produced which had no temperature-change of magnetic strength after ageing. Prof. Fleming then exhibited a number of experiments to show that the ferromagnetic bodies, iron, nickel and cobalt, all changed at a certain temperature, varying for each, into the paramagnetic state, in which they were practically non-magnetic. This change took place in nickel at about 340° C., and a pretty experiment was shown, in which a star-shaped disc of nickel, balanced on a pivot in front of a magnet, was set in rotation merely by being heated at one place. The disc in this way was rendered magnetically lop-sided, and the magnet continually pulled it round into a fresh position. In conclusion, some interesting experiments were performed to prove that the temperature at which this magnetic transformation took place was also marked by the occurrence of several other important physical changes.

Large Continuous Current Dynamos.—The most powerful continuous current dynamo now known is that constructed by the General Electric Company at Schenectady for the Louisville Tramways Company. This dynamo, which has 22 poles, will produce normally 2,400 kilowatts, at an angular speed of 75 revolutions per minute. In cases of emergency its available power can be augmented one-third, and raised to 3,200 kilowatts. The external diameter of the crown bearing the field magnets is 5·7 metres; the breadth of this crown is 1·25 metres. The diameter of the armature is 3·8 metres; the diameter of the commutator is 2·9 metres; that of the shaft 58 centimetres; the length of the armature is 1·5 metres; that of the commutator, 55 centimetres. The armature and its collector weigh 38 tons; the entire machine, 80 tons. Before this dynamo had been made, the most powerful type was that of 1,500 kilowatts, working the intra-mural railway of the Chicago Exhibition in 1893. Dynamos of this type have been installed at Philadelphia, Boston, and Chicago for the service of overhead tramways or railways. The tramway station at Brooklyn contains four, and two others are in course of installation. When the two latter are at work, the Brooklyn station will be next to that of the Niagara Falls, the most powerful electrical station in the whole world; but it will not long hold the record, as in two years there will be at New York a station of 70,000 kilowatts, supplying the whole tramway system of the town.

To our Readers.—As next Friday is Good Friday, our issue will be published on Thursday morning, and all matter for that number should reach this office a day earlier than usual. Advertisers, contributors, and correspondents, please note!

French Import Duties on Lead and Accumulators.—By an Act passed March 3rd, 1898, the import duties on lead, its rich ores and its various compounds, were modified or completed in accordance with the following table:—

Numbers.	——	General per 100 kg. in fr.	Tariff minimum per 100 kg. in fr.
239	Minimum	8.50	5.15
	Litharge and other oxides	8.75	5.30
225A	Salts of lead and chemical products with undenominated lead base	5 % *ad valorem* + 2.40 fr. per 100 kg.	5 % *ad valorem* + 2 fr. per 100 kg.
256	Acetate of lead ...	11 50	7.60
262	Carbonate of lead (white lead)	8 50	5.60
266	Chromate of lead ..	25.50	18 50
576	Pipes and all kinds of other work in lead ...	8.50	6.50
576A	Electric accumulators.	21 50	16 50

The Automobile Club of Great Britain.—This club intends, at Easter time, to make a tour on motor vehicles. The party will start from the club house on Thursday afternoon next, and journey through the southern counties, stopping at Guildford for the Thursday night, Winchester for the Good Friday night, Chichester for Saturday night, Worthing for Easter Sunday night, and Tunbridge Wells on Easter Monday night, and from thence returning to London. The carriages will in all cases be driven by amateurs. Fifteen owners of motor carriages have already notified their intention of joining the tour.

Obituary.—We regret to record the death of Mr. Stephen Alley, senior partner of the well-known firm of engineers, Messrs. Alley & Maclellan, of Glasgow. Mr. Alley's death occurred last week at his residence, Langside House, Glasgow.

A Coolgardie paper dated January 29th, records in very touching terms the death and funeral of Mr. Hubert Musgrove-Musgrove. By profession Mr. Musgrove was an electrical engineer, and was for some years representative in Australia of the Electrical Power Storage Company, but he was also an accomplished amateur violinist and a fluent linguist. Mr. Musgrove arrived in Western Australia a little over four years ago, and was well known and highly respected. He was only 37 years of age. Previous to going out to Australia, Mr. Musgrove carried on business in Glasgow for many years under the title of Norman & Son, and after converting the business into a limited company he became associated with the Electrical Power Storage Company. Latterly, however, Mr. Musgrove became interested in gold mining.

Burning or Barging of Refuse.—At a meeting of the Battersea Vestry last week, an important declaration was made on the subject of the disposal of refuse. For some time the Battersea Vestry endeavoured to destroy the parish garbage by destructors; but nine months ago this method was discontinued, and the refuse was consigned to Kent. Mr. West reported that the working of the new system was at first beset with considerable difficulties. There was, for instance, only one barge for conveying away the refuse, and a considerable quantity had still to be dealt with by the dust destructor. Notwithstanding this, however, the system had been a great success. It was estimated that, as compared with the cost of utilising the destructor, there would be a saving of £2,000 a year. Although only nine months had elapsed, and although the difficulties had been great, yet £1,600 had already been saved. He had no doubt that the estimate of £2,000 would be considerably exceeded.

Appointments.—Mr. Bates, of London, has been appointed electrical engineer to the Birkenhead Corporation by the Electrical Committee at £300 per annum.

The Co-operative Wholesale Society has appointed Mr. A. A. Blackburn, of Leeds, to the position of electrical engineer of their large works near Manchester.

The Electrical Installation at Oldham County Court.—In the House of Commons on Tuesday, Mr. Ascroft asked the First Commissioner of Works whether he was aware that local firms were not allowed to tender for the electrical installation recently put in the Oldham County Court offices; whether there was any rule which prohibited fully qualified firms tendering for such work, and whether he would consider the advisability of allowing all such firms in the future the opportunity of tendering for local work undertaken by the Board of Works. Mr. Akers-Douglas, in reply, said that there is no rule that prohibits qualified firms tendering for the work to which the question refers. In the present case the work had to be executed in a very short period of time for departmental reasons, and tenders were obtained from two well-qualified firms, who could be relied upon to do the work in the time required. Whenever circumstances permit, local firms will be invited to tender for works in charge of the Board.

Parliamentary Committee on Electrical Energy.—Yesterday (Thursday) Viscount Cross presided over the first meeting of the Joint Committee on Electrical Energy (generating station and supply) at the House of Lords, the members of the Committee being, besides the chairman, Earl Spencer, Lord Knutsford, Lord Monkswell, Lord Balcarres, Mr. Ashton, Mr. Kimber, and Sir Leonard Lyall. The points to be considered by the Committee we have already stated. The Committee sat in private, and decided to adjourn till April 21st, when Earl Morley and Sir Courtenay Boyle will be called as witnesses.

Lectures.—Mr. J. E. Stewart, manager of the Derby Electric Light Station, delivered a lecture on "Some of the Uses to which Electricity from the Corporation Supply can be Put," at Victoria Street Church Schoolroom, Derby, on Thursday last week.

Before the East of Scotland Engineering Association at Edinburgh on 22nd ult., Mr. R. W. Hogarth read a paper on "Recent Developments in Electrical Engineering." Electric traction and electric welding were dealt with.

The War Office and English Copper.—We must congratulate the War Office upon at last discovering that there is such a thing as English electrolytic copper. Up to the present the War Office have obtained their supplies from America, but we understand that four of the principal copper smelters in this country have been invited to send samples of their products to be tested by the War Office authorities.

London County Council Electricity Meter Tests.—On 29th ult. the L.C.C. finally approved of the revised rules and scales of fees for the testing of electricity meters and other services rendered by the Council under the Electric Lighting Acts and Orders.

Testing Accumulators.—As we go to press, Mr. Albert Campbell writes: "In the reply to my letter in your last issue your correspondent states that, when the voltage of a motor car battery has fallen from 50 to 45 volts, more current must be taken than at the start; but he does not assure us that this *can* be done in practice. His proposed test at constant watts does not, therefore, seem to correspond to anything possible in practical working."

Appointment Vacant.—The Dewsbury Corporation is wanting an electrical engineer (salary £250) to take charge of the electricity works. April 9th is the latest date for sending in applications to the town clerk.

Who Is It?—According to Wednesday's *Daily Telegraph*, an inmate of Spalding Workhouse Infirmary, who has just been removed to the workhouse at Docking, in Norfolk, has had a remarkable career. He was a son of a former Alderman of the City of London, who died worth £40,000. He was himself educated at Christchurch, and was a scholar and expert electrical engineer, but ultimately had to seek refuge in the infirmary at Spalding Workhouse.

Personal.—Mr. Lewis J. Steele, who was Mr. Gisbert Kapp's assistant at Messrs. Johnson & Phillips, and who has since acted as chief designer to them, is severing his connection with this firm after eight years, to take up the appointment of chief electrician to the well-known firm of Messrs. Verity, Limited, at their works, Aston, Warwickshire.

CITY NOTES.

Another Mutual Improvement Company.

The prospectus of another Mutual Telephone Company, whose aim is to improve the telephone service of Manchester and other places, has been issued. It is frankly admitted that it will be necessary, before any new service can be started, to obtain a license from the Post Office; but the organisers of the company do not feel inclined to make this application till at least £80,000 has been subscribed. The prospectus seems to base its claim for public acceptance mainly on the grounds that the company will introduce important improvements, and that hundreds of public bodies have passed resolutions in favour of the company. The scale of charges suggested is curious, and worth noting. Non-shareholders, within a mile radius of the Manchester exchange, will pay £6 10s. for each telephone; holders of five shares, £5 15s.; and holders of 10 shares, £5 5s. It would be interesting to know how many shares are necessary to obtain a telephone for nothing; or following the sliding scale still further, at what number of shares does the company begin to pay the shareholder for having a telephone.

The Brockie-Pell Arc Lamp Company.

It cannot be denied that the results of the 17 months' working of this company have been unfortunate. We are not going to say that the directors have not had stupendous difficulties to contend with, and many of the troubles that have been experienced are not likely to occur again; but there have been unsatisfactory incidents disclosed in the short career of the company that are regrettable in the extreme. Considering that nothing had been done in the way of organising a factory when the company was formed, the prospectus ought to have been expressed in more moderate language. Salaries and directors' fees are items that do not seem to be quite in accordance with the period of trial and error through which the company has passed. However, the shareholders are well advised in adopting the report and putting their trust in the future.

Electric Supply Company of Western Australia.

The prospectus of this company, with a share capital of £100,000 in £1 shares, was brought before the public in the early part of this week. Some of the directors are well known in the electrical world, the chairman being Mr. Bennett Fitch, a director of the St. James's and Pall Mall Electric Lighting Company, and three directors are on the board of the British Insulated Wire Company. Much is made of the fact that the objects of the company are to take over from the Westralian Electric Lighting and Supply Company, Limited, the existing system of electric lighting now being worked in the town of Coolgardie, Western Australia. It must be always a satisfactory feature to potential shareholders to know that they are taking over an established undertaking "already earning profits," but naturally it is assumed that an established business which requires a share capital of £100,000 to purchase and to work must be something exceptional. We will examine the established business as far as we can in a moment. In the meantime we would note that, though prosperity in Western Australia is a matter at which all right thinking men should rejoice, we are obtuse enough to suggest that the increase in the revenue of the colony which is made much of by the prospectus has very little connection with the electric lighting of Coolgardie. Now let us go a little closer into the business and concessions which are to be acquired by this company. Coolgardie seems to be very much of a mushroom town, and owes its sudden rise to the proximity of the Western Australian gold mines. It is only five years since the first settlement was made, but in November, 1897, the population of Coolgardie and district is given at 20,000. Truly a remarkable increase! The company acquires what is, no doubt, valuable freehold land in one of the main central streets of Coolgardie, on which works are built and electrical machinery erected. The concessions acquired include the sole right to supply electricity in Coolgardie for 25 years, and rights to carry electric cables to the gold mines. No doubt those are valuable privileges, and are worth something. That is not all, however, for the electric lighting business which is to be acquired has been working since July 10th, 1897, and the gross receipts are stated to be equivalent to £9,500 per annum. For these various items the sum of £70,000 is to be paid, which, at least, shows that the vendors have confidence in the value of the business.

No details are given of the size of the electric lighting plant, or of the original cost, and, indeed, there is a marked absence of information as to the value of the assets to be acquired for £70,000. It argues a large measure of faith in the public to propose a company, with a capital of £100,000, with such ill-defined assets and property as shown in the prospectus of the Electric Supply of Western Australia.

Metropolitan Electric Supply Company, Limited.

Sir Eyre M. Shaw, K.C.B. (chairman), presided on Tuesday morning over the eleventh ordinary general meeting of the above company, held at Winchester House.

The Chairman said: In rising to move the adoption of the report and accounts, I desire as usual to offer a few remarks, though I think that these accounts are given in sufficient detail to obviate the necessity of detaining you very long in explaining them. Dealing first with the capital accounts as shown in Statements 1 and 2, you will see that the only capital raised during the year has been £62,500, the balance of the £125,000 new capital issued in 1896, and which from June 30th, 1897, became part of the ordinary share capital of the company. Statement No. 3 deals principally with the expenditure on capital account amounting during the year to £93,795 16s. 10d., with a grand total of £850,831 10s. 9d., and a balance of £29,597 18s. 10d., which is now practically expended, a matter to which I shall have to refer later on. The principal items of expenditure have as usual been the continually extending mains, which account for £38,869 12s. 5d., and the expenditure on transformers and meters for the supply of the increasing list of our customers, who now number about 6,000. These two items, transformers and meters, with their connections, absorb £15,823 4s. 2d., making with the mains an expenditure of £54,692 16s. 7d., or considerably more than half of the total sum expended during the year. The remaining items of any importance are lands, £12,801 8s. 5d. being the cost of purchase of our new site for generating works at Willesden; buildings, £9,445 18s. 11d., represented by extensions at Amberly Road, Sardinia Street, and Manchester Square; and machinery, £15,367 16s. 1d., which has been expended on account of equipment of those extensions, an equipment which when completed will materially increase our facilities for supplying our customers. We will now turn to the revenue account, which shows the result and cost of our working during the year, and from this account it will be seen that the income from current is steadily increasing, giving a total revenue of £138,267 14s. 6d., as against £116,459 4s., an increase of about £22,000, or 19 per cent. The expenditure to earn this larger income also shows, as will be expected, an increase, but not to so great an extent, being for cost of generation £58,604, against £52,619, an increase of £5,985, or 11¼ per cent., principally due to the increased consumption of coal and oil, and a total revenue expenditure of £79,546, against £70,267 in 1896, being a total increase of £9,279, or 13 per cent. as compared with 19 per cent. increased income, as already stated. The increases shown in distribution have arisen from the extensions of mains and developments of the system of low pressure distribution, while the growth of management expenses has been caused partly by necessary additions to the company's staff, in order to cope with the rapidly increasing work, and partly by the larger amount of the directors' fees. With regard to these fees, I think it right to remind you that some years ago the board agreed among themselves to take a very considerably reduced remuneration from that allowed by the articles of association, until the company should be earning substantial dividends, and that even at the present time the full amount allowed by the articles is not drawn. As I informed you at our recent extraordinary general meeting, the number of new customers continues at even greater rate of increase than at any former period in our history, and there are many indications tending to point to a still more rapid growth in the immediate future. Believing as we do that to be truly a success the electric light must be regarded less as a luxury and more of a necessity, we have, after the most careful consideration, decided to make substantial reductions in our rates of charge from the commencement of the present year, which, though they may affect our revenue to some extent for a little time, will, we feel convinced, in the long run amply justify our policy by the extended business which it will bring to us. This continual increase, while it is extremely satisfactory as pointing to the continued growth of our business, involves us in the obligation of making adequate provision for our future requirements. I have already informed you of the reasons which led us to procure a most advantageous site at Willesden on which it is intended to erect large generating works, the existence of which will relieve us from any anxiety for many years to come. By gradually extending these works as occasion may arise—and there is ample space at our disposal for doing this—we can place no limit to the amount of power which can be produced. Intimately connected with these extensions as affecting our cost of manufacture and distribution, which it is our earnest desire to reduce to their lowest possible figures, is the development which we have now in progress for changing our system of supply in those portions of our areas where the lamp density warrants the laying down of low pressure mains, and we have every reason to hope that a large portion of this work will have been completed before the close of the present year. The mention of these new works leads me naturally to the question

of new capital. Before, however, dealing with this matter, I propose to lay before you, as briefly as possible, the result of our recent negotiations with the holders of the founder shares. You will remember that, at the last general meeting, an undertaking was given by me that efforts would be made to come to an arrangement with the founders for the extinguishment of their rights. We accordingly gave the subject our most careful consideration, and after taking the opinion of our financial and legal advisers, we prepared a scheme which had, as its basis, an allotment of 140 new ordinary shares at par in exchange for each founder share. The agreement embodying these proposals was sent to the founders, together with a circular, in which the views of the directors were fully explained. The meeting which was held to consider these proposals resulted in the appointment of a committee of the founders to negotiate with the directors, and the result of the deliberations of this committee is embodied in the following letter:—"The committee appointed by the holders of founder shares to report on the offer made by the board has very carefully and fully considered the directors' proposal, and has unanimously determined that the offer is inadequate, and should be declined. The committee is confirmed in this opinion by comparing the terms with those accorded to founder shareholders in other leading electric supply companies. The committee has ascertained that holders of a considerable number of founder shares prefer to remain as they are, and will not entertain any offer less favourable than the allotment of 300 ordinary shares at par." To this letter the board replied that this offer was not one which they could consider themselves justified in recommending the ordinary shareholders to accept. As the result of another attempt to effect an arrangement, we have lately received a further letter from the founders' committee suggesting that the founders might accept an allotment of 250 ordinary shares, but the directors are still of opinion that these terms are far too high, and that the ordinary shareholders would be unwise to accept even this reduced basis of settlement. We very greatly regret the failure of these negotiations, for it would manifestly have been to the best interests of the company as a whole that they should have succeeded. In our circular to the founders we indicated that in our opinion the ordinary shareholders could not be asked to pay a premium on any issue of new shares, seeing that the effect of this premium would be, as we think, unreasonably to improve the position of the holders of the founders' shares at the expense of the ordinary shares. To this opinion we adhere, and unless within a very short time we are able to come to terms with the founders we shall probably issue a large portion of the new capital to the existing shareholders at par, though it is our intention to postpone dividends on these shares until the new works can fairly be expected to be earning their proper proportion of revenue. We have been informed that at least one of the founders intends to attempt to restrain us by legal means from adopting this course on the ground that by doing so we are prejudicing the rights of the founders. Well, gentlemen, much as we regret the possibility of this course being taken, we think it best that once and for all the discretion of the board in matters of this kind should be clearly defined. One other point connected with this subject, and I have done. It is best raised by reading to you from a letter we have received from Mr. Orrell, in which he says:—"Permit me to point out to the directors that the item 'Premiums on debenture stock and new shares,' &c., £35,429 9s. 7d. in account No. 3, capital account, is clearly not an item of capital account, but of revenue, and is a net profit, and should be treated as such, and be placed in Account No. 4, which, after deducting 10 per cent, in accordance with Art. 132 of the company's articles of association, is available for dividend, and should be paid to the shareholders. I hereby give notice to the directors that I object most strongly to this sum of £35,429 9s. 7d., less 10 per cent. being placed to reserve funds without the consent of three-fifths of the holders of the founders' shares being obtained, and it is my present intention of moving at the general meeting that the accounts be rejected and amended in manner above stated, and the full dividend paid. It is with very great regret that I feel compelled to take this step, which is most distasteful to me, but there is no other alternative, after the expression of the views of the directors contained in their letter of January 20th, 1898, with regard to the rights of the founders' shares, and the expressed intention of the directors to issue to the shareholders *pro rata* a large amount of ordinary shares at par, which I am advised by Mr. Charles Jenkins, Q.C., would be a breach of trust on their part. What security have the founders' shareholders that if the net profits fall short at any future time the directors will not appropriate this £35,429 9s. 7d., to augment the dividends on the ordinary shares? I trust the directors will give the founders some assurance that in issuing the new capital they will obtain the best price which can reasonably be obtained for the new shares, and I feel sure that the consent of three-fifths of the holders of the founders' shares will be obtained to place the whole of the premiums to a reserve fund for the benefit of the company; but in this matter I speak for myself only." I think you will agree with me, gentlemen, that Mr. Orrell has succeeded better than I could ever have ventured to do in justifying the policy of the board, by pushing to its extreme limit the consequences of issuing shares at a premium. He asks us to place the whole of the premiums already received (less 10 per cent.) to revenue account, and a little further on he requests us to give the founders an assurance that the board will obtain the best price they can get for the new shares, feeling sure (though he only speaks for himself) that the founders will agree to the placing of such future premiums to reserve. With regard to the sum of £35,000, this has not been treated, and in our opinion ought not to be treated, as a revenue profit for any dividend purpose whatever, and the same remark applies to any future premiums. If Mr. Orrell's contention be valid, that it is the duty of the board to treat premiums as profits divisible as dividend, after deduction of 10 per cent. as reserve, it will be seen that, the dividends being immediately forced up above the 7 per cent. limit, the founders will obtain a very large proportion of such premiums at once, while the security of the ordinary capital in respect to its future repayment will be proportionately diminished. Of course, whatever Mr. Orrell may say, the holders of founders' shares cannot treat premiums both as revenue profits, and as reserve as well, but it is clear that in either case the issue of shares at a premium will be more to their benefit than to that of the ordinary shareholders. With these remarks, gentlemen, I beg to move the following resolution:—"That the report and accounts for the year ended December 31st, 1897, presented to this meeting be and are hereby approved and adopted, and that in addition to the interim dividend of 5s. per share paid on October 15th, 1897, a further dividend of 7s. per share on the whole of the original ordinary shares, and of 6s. per share on the new shares of the company be and the same is hereby declared, such dividends to be payable on March 30th, 1898, to all holders on the company's registers on March 19th, 1898."

Admiral Sir John Hay seconded the motion.

Considerable discussion followed, and several speakers expressed the hope that every effort would be made to arrange the matter amicably with the founders.

Mr. Orrell moved and Mr. Baldwin seconded an amendment that the report be not adopted; but the Chairman pointed out that was simply a negative to the motion for the adoption of the report.

The report was carried by a large majority.

Willans & Robinson.

Mr. M. Robinson presided on Wednesday afternoon at the ordinary general meeting of the shareholders of the above-named company held at the City Terminus Hotel, Cannon Street. After the secretary had read the notice convening the meeting, the directors' report and accounts were taken as read.

The Chairman moved the adoption of the report and statement of accounts, and in so doing said he thought he might safely state that, in view of the many difficulties they worked under last year, the accounts were equally satisfactory for the past and promising for the future. If the great strike passed them by, so far as concerned the relations between the company and their own workpeople, which were never better, yet many firms upon whom they depended for assistance in the form either of stores or of finished engine parts, or of tools for their works, had their shops brought wholly or partly to a stand. These labour troubles had reflected heavily upon the company, causing some of their capital to remain idle, and keeping down their output of engines. Tools ordered over a year ago were still undelivered, and thus a part of their capital had been idle for a year, drawing interest while producing no engines. They were, however, gradually surmounting the many troubles entailed by the strike, and he had no doubt that they would agree with him that the balance-sheet now submitted was even more satisfactory, as the outcome of a difficult time, than if it represented a period when all had gone well with them. The moderate increase in the dividend now recommended might have been paid before, but the fixed policy of the directors was to make sure of every step before taking it. Depreciation had increased by over £1,100 for the half-year, and this item they must expect to increase further, as their new works were gradually completed. To the debenture sinking fund they had carried the usual contribution of £2,000, and to the reserve fund proper the increased sum of £1,500, making no less than £6,500 reserved out of the profits during the 12 months. The prospects of work before them were all that they could desire. It was no longer doubtful that electric traction was about to receive a great development in this country, and in this the Willans engine would play a leading part. Already an engine to indicate up to 1,500 horse-power was under construction for traction work, and they had been called upon to prepare designs for an engine of 2,500 horse-power. The size of the engines they made had increased to a startling extent. This development threatened to go beyond the utmost anticipation of the directors, and to involve additions to their plant beyond what the present capital provided. The question, however, was not immediate, but it was well to mention it. Fortunately at Rugby they were in a position where extensions, when necessary, could be made rapidly and economically. They hoped that the relations between the company and their workmen would in the future be even better than they had been in the past, for in pursuance of a long-desired scheme for binding their old hands more closely to them, they had instituted, since the close of the strike, a system of long-service bonuses, which they thought would give their men a strong inducement to remain with them. He was glad to say that this offer had been received with much satisfaction by their men. Having called attention to certain items in the balance-sheet and loss account, he said he might anticipate a question, which would otherwise doubtless be asked, as to the success of their recent small issue of shares—3,000 preference and 3,000 ordinary shares were to be issued, but owing to the effect of fractional holdings, only 2,838 preference and 2,854 ordinary shares were provisionally allotted, subject, that was, to acceptance. The numbers accepted were 2,447 preference and 2,296 ordinary, and the balance was applied for 10 times over by their own shareholders alone.

Mr. A. Holland seconded the motion, and observed that the shareholders had abundant reason for gratification, for the business had grown very rapidly.

The motion was carried, and a further resolution to pay a dividend at the rate of 8 per cent. on the ordinary shares was agreed to.

Mr. M. H. Robinson and Capt. Saukey, the retiring directors, were re-elected.

Brockie-Pell Arc Lamp, Limited.

The directors in their report state that they regret very much that the result shown by the accounts is not more satisfactory. This is due principally to the long period taken in equipping the works with the various machines, and making the numerous patterns and special tools required in the manufacture of the lamps. The first 100 lamps, made entirely at the company's factory in Tabernacle Street, were not completed until the end of July last, so that the business has only been in full swing for a period of from five to six months. As showing the estimation in which the company's lamp is held, it will be satisfactory to shareholders to know that the whole of these 100 lamps were erected in the principal streets of the city of Glasgow, to replace those of other makers. Amongst the numerous customers of the company during the period under review, may be mentioned several departments of H.M.'s Government, corporations, vestries, exhibitions, railways, &c. The orders received from month to month have shown a steady increase. The total number of "Brockie-Pell" lamps supplied to the public in 1897 exceeded that of 1896, thus showing continued progress. In order to save inconvenience to the public during the time the factory was being equipped, the directors allowed the late makers to continue the manufacture of the lamps for some months, and to execute the orders they had received upon payment of a royalty to the company. The directors also agreed to take over from them the stock of lamps left upon their hands after such orders had been provided for. It will thus be seen that the company has not had the benefit of any manufacturing profit on the greater part of the business transacted since its formation. The engineering strike, which lasted about six months, caused a considerable amount of trouble and loss to the company. Great difficulty was experienced in obtaining delivery of material required by the factory, and orders were kept back by customers in consequence of their finding it impossible to procure the necessary machinery for operating the lamps. All the preliminary expenses have been written off, and also a portion of the outlay on furniture and tools. After lengthy negotiations the directors signed a contract in October last for the sale of the French and Belgian patents for £3,000 in cash, and shares in a company to be formed. £500 has been received on account. Mr. Brockie has taken out several new patents in 1897 for further improvements in arc lamps and accessories. These belng to the company, and it is anticipated that they will prove of value, and create an extension of business. The company has also a considerable interest in a patent granted to Mr. Brockie for an automatic lathe, worked on an entirely new principle, which will probably prove a valuable asset in course of time.

Lord Suffield presided over a crowded meeting of shareholders of this company, held on Tuesday at Winchester House. The chairman went through the various items of the report which is given above. He said it was not until the end of 1896 that they were able to enter the premises they had secured in Tabernacle Street. In the meantime, however, Mr. Brockie had not been idle, and had been able to obtain machinery from the Continent for the purpose of carrying on the work. It was not, however, till March of 1897 that work was commenced upon the various special tools they required. With a view to saving time, a considerable number of those tools were made to their design by others; but notwithstanding this help, week after week passed, and they appeared to get no nearer to the desired end. They knew that Mr. Brockie was doing his utmost, and considering the enormous amount of detailed work that required his personal supervision, there was no reason to be dissatisfied with the length of time taken to bring the factory into working order. When the first 100 lamps were completed by their own men, namely, at the end of July last, that left practically only five or six months in which to make any manufacturing profit. Paragraph No. 7 showed continued progress in the sales of the lamps. Of course, they had not had the full benefit of the increased sales, and had to be satisfied with receiving royalties only. The new patents granted to Mr. Brockie last year included some important improvements in the construction of arc lamps and accessories in connection with them, which they fully believed would add to their business, and practically extend the time of the monopoly. Before putting the resolution, they would no doubt like to hear something of the prospects of the company for the current year, and he had much pleasure in saying that the volume of business at present in hand was very satisfactory. The value of unexecuted orders amounts to between £8,000 and £9,000, although they have not yet reached the end of the first quarter of the year.

Sir F. D. Dixon-Hartland seconded the motion. In doing so he said he could not but feel that the accounts were very disappointing, but at any rate they were honest accounts, showing the exact state of the facts. There had been no attempt to keep anything back. He did not think that anybody who was not a director of the company could have had the slightest idea of the work, the anxiety, the trouble that had been caused to the board. They had, to a certain extent, been environed by difficulties which were unforeseen at the time the company was brought out, but he believed that at the present moment they were on the road to success. They took over a business which had been carried on by Messrs. Johnson & Phillips. They were informed that the works would take about four or five months, but in reality it was nearly 12 months before they were got into working order. They had had to make all the parts, and all the tools for making the parts, and that took a considerable time. Another difficulty was, that Messrs. Johnson & Phillips knew that they had got a good thing, and were most anxious not to give it up. At first they said that Mr. Brockie and Mr. Pell had no right to sell the patents to anybody else, that they had a legal right to keep the patents as long as they existed, and that all Mr. Brockie and Mr. Pell could do was to give a concurrent right to this company. Thanks to the energy of the solicitor, the directors were able to get over those difficulties, and at last Messrs. Johnson & Phillips gave up that contention. Then it was found that they were continuing to manufacture the lamp, and for the sake of peace and quietness an undertaking was taken from them that they would make no more of the lamps. The company bought the whole of their stock of lamps. Of course, all this was not done without an immense amount of thought and labour, and he was sorry to say that they had now moved for an injunction against Messrs. Johnson & Phillips for infringing the patents. In a letter which they had written, Messrs. Johnson and Phillips said that there was only a 2 per cent. profit on the manufacture of the lamps, but if that were so would they fight so hard, or would they have paid 7½ per cent. upon the gross list price of the lamps? The board had put an end to dual management, and now had one responsible managing director, who would take sole charge of the work so far as the commercial part was concerned. He had very little doubt that before long there would be good profits for the shareholders. It had been suggested that the directors had helped to rig the market, but he did not believe that one of them had bought or sold a single share. They had nothing whatever to do with the market. Their object was to make the company a success, and whether the shares were up or down it was not for them to consider.

Mr. Clement thought the company was floated on conditions that were entirely unjustifiable. No doubt there was good reason in the delays that had arisen. He asked whether they had guarantees for payment of the Belgian rights?

Mr. Skipworth: So far as he could see, their assets were not worth 60 pence, and that was all they had to show for their £60,000. How was it that they had only got £500 for the Belgian and French patents? He moved as an amendment: "That the directors' report be received, but that the same be not adopted, pending the report of a committee of investigation to be now appointed by the shareholders."

Mr. Waugh said he had confidence in the directors, who held nearly two-thirds of the shares, and he did not see why a committee should be appointed.

Sir F. D. Dixon-Hartland, in reply, said the whole of the amount on the 5,000 shares had been called up, but the time was not yet up for payment. With regard to money to go on with, there was about £1,000 to come from the shares. Then £3,000 was expected in July for the patents. There were also book debts, and the company was not going to manufacture £8,000 or £9,000 worth of lamps without getting something for them. The directors, therefore, hoped that with a little borrowing from the bankers they would be able to get through until such time as greater profits could be made. The patents were examined by an eminent firm of patents agents, and therefore it must be presumed that they were perfectly good. The factory was leased for 21 years. With regard to the foreign patents, some gentlemen approached the directors and said: "We are prepared to give you £3,500 in cash for your patents for France and Belgium; we are then going to float a company for those countries, and then we shall give you one-fourth of the shares." The board were not going to be satisfied with the output for the last five months; they hoped to double and even quadruple it, and then the working expenses would drop in proportion, and there would be a chance of making profits. The directors were quite willing to draw only two-thirds of their fees until the company proved a success. If at the end of another 12 months, satisfactory results could not be shown, other men might be elected on the board.

Mr. Skipworth withdrew his amendment, and the motion for the adoption of the report was then agreed to.

The retiring director, Mr. H. W. Maynard, was re-elected; the auditors, Messrs. Mellors, Basden & Co., were re-appointed, and the proceedings terminated with a vote of thanks to the chairman.

Direct Spanish Telegraph Company.

The Marquis of Tweeddale (chairman) presided over the ordinary general meeting of the shareholders of the above company, held at the offices, Winchester House, on Tuesday, and in moving the adoption of the report, said he must express the sincere regret of the directors, which he felt would be shared by everyone connected with the company, at the death of Mr. Etlinger. Turning to the accounts they would observe that the balance to the credit of revenue account was £12,975 6s. 4d., and after adding £5,000 to the reserve fund, the directors recommended that the balance be distributed as follows:—10 per cent. on the preference shares, and 4 per cent. on the ordinary shares, absorbing £5,486 4s. Half of the amount was distributed in October as an interim dividend. The traffic receipts showed a decrease of £2,927. With regard to that decrease, only £674 was applicable to the first half of the year of 1897, when the same rates as in 1896 were in force. The remainder of the decrease took place in the second half of the year, and no less than £1,974 was due to the reduction in the rates agreed to at the international telegraphic conference, and to the mode of counting words and figures agreed to at that time, which came into force on July 1st. Without that reduction, the traffic for the year was only £983 less, which would have been very satisfactory, considering the very exceptional traffic they enjoyed in 1896. The working expenses were £223 8s. 11d. in excess of the year 1896. The increase was on account of salaries, amounting to £204 2s. 11d. Their former chairman, Sir John Pender, alluded to that matter some years ago, and pointed out that it was absolutely necessary that some arrangement of the sort should be made if they expected to secure the services of good men. There was also a small increase of £39 for repairs and

renewals of instruments and landlines. The company's cables, and the landlines in connection with them, have continued in excellent working order during the year. At the last general meeting he referred to the litigation connected with the Bilbao breakwater, and said that the case would be tried before the tribunal in Madrid in April. The decision, as they probably were aware, was adverse to the company. The decision and judgment was based on points of law, and it was final, and the directors had, therefore, transferred the balance of revenue, £2,489, to the reserve fund towards payment of the cost of removal. The directors, in the exercise of their judgment, had appointed Mr. F. Johnson to the board. He was an able man of business, and happily a good deal younger than some of them, and would therefore, he hoped, have a prosperous career in connection with the company. As they knew, the leading telegraphic companies thought it right to celebrate the Jubilee of the Queen by granting bonuses to their employés, and the board felt that it would not be fair to make any exception to the employés of that company, who were in no way inferior in zeal to the employés of other companies, and so the bonus was granted to them. It was equal to 10 per cent. on the annual salary of members of the permanent staff with five years' service, and 5 per cent. on the salaries of those with less service. The sum was not a very important one, and he was sure that it would act as a stimulus to the employés of the company. He might mention that since January 1st of that year, up to the present date, the traffic was in excess of the corresponding period. The receipts were not quite so large, but that was due to the reduction to which he had referred. They began the year, therefore, on the whole, very prosperously, and he trusted that prosperity would last.

Mr. J. D. Pender seconded the motion.

Mr. Stimpson suggested that the board might see their way to pay a larger dividend.

The Chairman said they wished the dividend might be larger, and now they had got rid of the Bilbao expense, he hoped the accounts would show better.

The report was adopted.

The Guildford Electricity Supply Company, Limited.

The directors in their annual report state that they are calling the ordinary general meeting for 1898 earlier than in previous years, in order to present to the shareholders the accounts for the year ending December 31st, 1897, as they are desirous that the company's financial year may in future coincide with the calendar year, which is the period for making up the annual accounts required to be furnished to the Board of Trade. The number of installations connected with the company's mains is increasing, and now amounts to 52.

The directors are well satisfied with the result of the first complete year's working, and are gratified to think that the stage of remunerative business has now been reached, the revenue account for the quarter ending December 31st, 1897, showing a profit of £67 6s.

The subscribed ordinary capital has now reached £7,670; but, as it has been decided to increase the plant and extend the mains at once, further subscriptions for ordinary shares, to be paid in full on allotment, are invited from the existing shareholders.

Shareholders are reminded that the ordinary shares are entitled to the first profits in each year to an extent sufficient to pay a dividend of 6 per cent. thereon, before the founders' shares receive anything. The ordinary shares take also three-fourths of any surplus profits over 6 per cent., the founders' shares being entitled to the remaining fourth. Also, that the company holds a provisional order, granted by the Board of Trade and confirmed by Act of Parliament (57 and 58 Vict., C. cxv.), for supplying electricity in the municipal Borough of Guildford, and that under this order the company has a practical monopoly in the town for 35 years from July, 1894.

The annual general meeting of the company was held last Thursday at Guildford. Dr. F. R. Russell, chairman, presided, and said as they met only so recently as three months ago, he had little to add to what he then told them of the progress of the company. During the last quarter of last year they made the very fair profit, considering the company had only been running a year, of £67. Of course, that did not make up a profit on the whole year in their favour, because in the first two quarters of the year there was a loss. The last quarter, however, paid very handsomely. The company had now reached the maximum expenditure, and they could double the number of lights without spending any more money, except in the way of coal. But it was absolutely necessary during this year that they should add to their plant, and also lay some extra cables, and they must during the year raise further capital to the extent of £3,000 or £4,000 at least, or even more if they could get it. Since that report £430 in new shares had been paid in. He concluded by moving the adoption of the report and balance sheet.

Mr. Wheeler seconded.

Mr. Money-Kent gave some figures respecting the accounts, the report and accounts being then passed.

Bournemouth and Poole Electricity Supply Company.

Lord Rathmore, who presided on Monday last at the statutory meeting of the Bournemouth and Poole Electricity Supply Company, held at Winchester House, stated that the company's liability to the vendor company in respect of the purchase price had been discharged, and the purchase completed. An application had been made to the Stock Exchange for a special settlement and quotation, and the directors were daily expecting a notification that the same had been granted.

Evered & Co., Limited.

The report and balance-sheet shows, after providing for debenture interest, amounting to £2,416 13s. 4d., a net profit of £25,146 19s. 8d., making, with £7,288 11s. brought forward from 1896, the sum of £32,453 10s. 8d. to be dealt with. An interim dividend at the rate of 7½ per cent. per annum to June 30th, 1897, has been paid, absorbing £6,402 18s., and the directors propose to pay a dividend at the rate of 7½ per cent. per annum for the remaining six months, which will absorb £6,402 18s., and to pay a bonus of 2½ per cent. per annum for the year, £4,268 12s. The directors state that there has been an increased amount of business done, which they deem very satisfactory. This year the full amount of paid-up capital ranks for dividend. Further provision for increased trade has been made in the way of additional buildings at both works.

Mr. A. H. Griffiths has resigned his position as managing director in Birmingham, and Mr. R. B. Evered, the chairman of the board has undertaken the sole managing directorship, assisted in London by Mr. G. J. Evered, and in Birmingham by Mr. R. G. Evered.

British Electric Traction Company, Limited.

The directors in their report for the period from October 26th, 1896, to December 31st last, state that the company was registered in October, 1896, and 20,000 of the 30,000 ordinary shares offered for subscription were allotted. The subsequent issue of the remaining 10,000 ordinary shares produced a net premium after payment of expenses of £1,218, which amount has been applied in reduction of preliminary expenses account. Since the closing of the books an issue has been made of 10,000 6 per cent. cumulative preference shares of £10 each, at a premium of £2 10s. per share. The proceeds of this issue will be brought into the next account. The gross profits amount to £14,422, and after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with, there remains a net profit of £9,804, which the directors propose should be carried forward to next account. Arrangements for the adoption of electric traction at the following among other places are in various stages of progress:—Coatbridge and Airdrie, Cork, Crewe, Dudley, Stourbridge and district, Gateshead-on-Tyne, Hartlepool, Lake District, Kinver, North Shields, Tynemouth and district, North Staffordshire, Oldham, Ashton, and Hyde, Kidderminster and Stourport, Middleton and district, Paisley and district, Potteries district, South Staffordshire, Swansea, Wolverhampton and district. Provisional arrangements have also been made and negotiations are pending in regard to a number of other places; but it would be premature, or inexpedient, to refer to them in this report. In some of the above cases agreements have been made for the purchase, or leasing, of existing tramway undertakings, while for other undertakings Parliamentary powers, or orders under the Light Railways Act, have been secured or applied for. In some instances the company has acquired the majority of the shares of existing tramway companies, and controls the business of such companies with a view to the adoption by them of electric traction. In a few cases the arrangements have been made in co-operation with other parties. With regard to South Staffordshire, the existing electric tramways are being worked by the company, and are a source of income. Contracts have been placed with responsible parties for the work of construction, and electrical equipment at Dudley, Stourbridge, Hartlepool, Kidderminster, and Stourport, North Staffordshire, Oldham, Ashton and Hyde, and Potteries, and the work is being proceeded with.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum, for the quarter ending March 31st, 1898; such dividend to be payable on and after April 26th next.

Globe Telegraph and Trust, Limited.—An interim dividend of 2s. 6d. per share has been announced.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 25th, 1898, were £2,379 14s. 7d.; corresponding period, 1897, £2,207 19s. 5d.; increase, £171 15s. 2d.

The City and South London Railway Company.—The receipts for the week ending March 27th, 1898, were £1,066; week ending March 28th, 1897, £974; increase, £92; total receipts for half-year, 1898, £13,891; corresponding period, 1897, £13,791; increase, £100.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 26th, 1898, £111 9s. 8d.; total receipts to March 26th, 1898, £1,277 18s. 7d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, March 25th, 1898, were £414 11s. 1d.; corresponding week last year, £476 19s. 10d.; decrease, £62 8s. 9d.; passengers carried, 69,266; corresponding week last year, 72,768; aggregate to date, £4,793 9s. 0d.; aggregate to date last year, £5,146 1s. 8d.; decrease to date, £353 4s. 8d.; mileage open, 8 miles. Cars, 1898, 211; 1897, 278. Miles, 1898, 18,979; 1897, 19,865.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 27th, 1898, amounted to £1,303; corresponding week last year, £1,336; decrease, £33.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 25th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,622.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 23rd.	Closing Quotation, March 30th.	Business done during week ended March 30th, 1898. Highest.	Lowest.
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 62	59 — 62	60½	58
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	109½ 110½	110 111	110⅞	108⅞
3,038,020£	Do. do. Defd.	Stock	...	...	...	11⅜— 12⅜	12½ 13	12⅝	12⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ - 17¼	16½ 17	16 11/16	16½
75,000£	Do. do. 5 %, Debs., 2nd series, 1925	100	5 %	...	...	112 -116	112 - 116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3⅛	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	185 190	...	...
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	104 —106	106⅞	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	⅞— ⅞	⅞ — ⅞	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	6½ - 7⅛	6½— 7⅛	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ - 15½	14½— 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 -106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10⅝ - 11⅛	10⅝ - 11⅛	11⅛	10⅝
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —101	99 —103	10 ¼	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17⅝ - 18⅛	17⅝ - 18⅛	18⅛	17⅝
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½— 19½	18½ - 19½	19	18⅝
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 - 103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 - 131	128 —131	129	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7%	...	18⅝ - 19¼	18⅝ - 19¼	19	18⅝
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,325	100	5 %	5%	...	99 —103	99 103	...	...
100,500£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 - 103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	...	...
35,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 - 103	...	...
46,500£	Do. do. do. to Bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 - 103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	10	4 %	4%	...	102 —105	102 - 105	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.), 1 to 8,000	20	4 %	4%	...	107 —110 %	107 -110 %	107	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅜ - 12¼	11⅜ - 12¼	11⅞	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 18	17½ - 18	17⅝	...
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29½ - 30½	29½ - 30½	...	...
160,000£	Do. do. do. 5 % Debs	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 - 55	52	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 - 109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6½— 6⅝	6 — 6½	6⅝	5⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜ - 6¼	5½ - 6	6⅛	5⅜
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —107	102 —107	103£	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅜ - ⅜	⅜ - ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	8	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 - 145	140	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	105 -108	105 - 108	107½	...
15,609	West African Teleg., Ltd., 7,581 to 23,189	10	4 %	nil	...	3½ 4½	3½ 4½	...	...
213,400	Do. do do. 5 % Debs.	100	5 %	5 %	...	101 104	99 102	101½	...
64,269	Western and Brazilian Teleg., Ltd.	25	3 %	2 %	...	11⅜ - 12¼	12 - 12½	12	11⅞
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	7½ - 8	7⅝ 8¼	8	7⅝
33,129	Do. do. do. Def. Ord	5½	1 %	...	...	4¼ — 4⅝	4½ - 5	5⅛	4 9/16
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	106 —109	106 —109	108½	107
88,321	West India and Panama Teleg., Ltd.	10	⅛%	1 %	...	⅛ — ⅜	⅛ — ⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½— 8	7½ - 8	7⅞	7½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600	100	5 %	5 %	...	105—108	105 - 108	108	106
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ 14½	13½ - 14½	13⅝	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ - 6⅝	6 — 6¼	6¼	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 19,277	5	5 %	5 %	...	10⅜ — 11½	10½ - 10⅝xd	10⅝	10⅜
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	...	115 —117	115 -117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001– 90,000	10	5 %	7 %	10 %	26 — 27	25½ - 26½	26	25⅝
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	12½— 13½	12½— 13½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½ - 18½	17⅝	17½
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 - 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1– 30,000	10	nil	nil	nil	14⅜ - 15½	14⅜ - 15½	15	14⅜
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15½— 16½	15½ - 16	15 1/16	...
17,400	Edmundsons Elec. Corp., Ltd , ord. shares 1—17,400	3	...	...	...	3½— 3⅝	3½— 3⅝	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5		...	...	11 — 12	10½ - 11½	11½	11½
10,000	Do. do. 7 % Cum. Pref.	5	...	...	...	11⅜ - 12¼	11⅜— 12	11⅞	11 13/16
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	4 %	5 %	6 %	21 — 22	20 — 21	21	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	3 %	20½ 21½	20 — 21	21½	21
220,000	Do. 4½% first mortgage debenture stock	..	4½%	4½%	4½ %	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½ - 20½	19½ - 20½	2 3/8	20 3/16
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½%	18 — 19	18 — 19	18⅝	18½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 - 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	4 %	107 - 110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅜— 2⅝	2½— 2⅝	2⅝	2½
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	17 — 18	17 — 18	17⅝	17

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation. March 23rd.	Closing Quotation March 30th.	Business done during week ended Mar. 30th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16½ — 17	16 — 16½	16⅝	15⅞
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	8	...	...	...	1⅞ — 2	1⅞ — 2	1 11/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼ — 2⅜	2¼ — 2⅜	2⅜	2¼
125,000	Do. do. 4½ % Perp. Deb. Stock.	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½%|2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19 894	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 11	10⅞	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼ — 6⅜	6¼ — 6⅜	6⅜	6⅜
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜ — 4⅞	4⅜ — 4⅞	4 13/16	...
630,000	City and South London Railway	Stock	1 3/16 %	1 3/16 %	1⅞ %	66 — 68	66 — 68	68	67⅜
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2½	1⅞ — 2¼	1⅞	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ — 3	2¼ — 2⅜	2⅜	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	103	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ — 2⅞	2⅝ — 2⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	106⅝	106½
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,803	2	...	...	...	⅛ — ¼	⅛ — ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅛ — ¼	⅛ — ¼	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½ — 23½	22 — 23	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 — 115	...	...
50,000	India-Rubber, Gutta Percha and Telegr. Works, Ltd. ...	10	10 %	10 %	10 %	21½ — 22½	21½ - 22½	21⅞	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —108	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½%	10⅜ — 10¾	10⅜ — 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	36 — 39	35 — 38	36½	35
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 — 138	135 —138	135½	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

***Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.**

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16⅜—17½; 1st Preference Cumulative 6 %, £5 (fully paid), 8⅛—8⅜. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

***T. Parker, Ltd., £10 (fully paid), 14—15.**

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The Practical Operation of Multiphase Currents. By T. Hawkins, Member. March 14th, 1898.

(*Continued from page* 422.)

In a power installation, the generator is the part which is usually well protected, and gets the best attention. If a continuous current machine is used, the brushes will, at intervals, require to be adjusted and renewed, and the commutator trued up and kept clean; still there is always a skilled attendant at hand to keep the machine in order. It is, however, the motors, scattered in many instances over a considerable area, which have often the greater strain and harder work to do, and yet have less attention where the three-phase system to my mind has the advantage, especially where motors are only required to run at one constant speed.

As regards the line, a saving of copper is effected by using the three-phase instead of the continuous current system, but there must be three wires if the former be used, which brings the cost of the distribution on a low pressure system to about the same.

At the works of the General Electric Company, Limited, at Manchester, there is a three-phase power plant. The generator has an output of 100 H.P. at a pressure of 190 volts, and runs at 450 revolutions per minute, giving 45 cycles.

The following is a list of the motors:—

No.	H.P.	Speed.	Geared to.	Kind of gearing.	Starting device.
1	24	910	Shafting	Belt	Liquid resistance in stator.
1	18	910	Shafting	Belt	"
1	9	910	Shafting	Belt	None.
1	3½	910	Boring machine	Belt	"
2	3½	1,360	Shafting	Belt	"
1	3	1,360	7 ft. radial drill	Worm gear	"
1	2	Variable	Lathe	Belt	Resistance in rotor.

The 24 and 18 H.P. motors are not working on more than ⅔ load. Each motor drives a 120 feet length of main shafting at 300 revolutions per minute, the main shaft being loaded along its entire length by high speed lathes and other machinery. The other belted motors drive shafting in the erecting shop, and are loaded nearly to their rated capacity.

In addition to the above, there are three motors, 6 H.P., 4½ H.P., and 1 H.P., used on a 5-ton 3-motor crane. The reduction of speed is obtained by worm gearing running in an oil bath. This gearing is most carefully cut, the thrust of the worm being taken up by ball bearings.

The 6 H.P. and 1 H.P. motors are mounted on the crab and have only one speed, being switched in and out of circuit without the use of any starting device. The lifting and transverse motions are limited to one speed. The 4½ H.P. motor gives the longitudinal motion, and has two speeds: full speed and half speed. The higher speed is obtained by halving the number of stator poles, this operation being performed by a throw-over switch. The starting and reversing is done by a second throw-over switch.

For cranes above 5 tons, the lifting and longitudinal motors are equipped with a starting device, connected to the rotor through slide rings. Such an arrangement has not the peculiar property of the series-wound continuous current motor, of self-regulation of speed in accordance with the weight being lifted; but this is the only advantage that the continuous current motor has over the three-phase machine. This, I think, is fully compensated for by the less delicate and complicated equipment the latter requires. The three-phase motor will stand a heavy overload or sudden reverse without fear of damage.

Usually the lifting motor is designed for a maximum speed at heaviest load. This speed cannot be increased for lighter loads, but can be regulated at will under such a limit.

The Liverpool Grain Storage and Transit Company, Limited, have adopted a three-phase plant for their storage warehouse at Bootle. It has been running some 15 months, and there are at present nine motors, giving a total of 150 H.P. The generator has an output of 165 H.P., and is coupled direct to a Belliss engine. They have no reserve generator, and do not stock any spare parts for either generator or motors. An extension of this plant is now in progress, consisting of two 48-H.P., and one 60-H.P. motors.

This installation furnishes an example where lighting and power is taken from the same mains. There are about 200 lamps, which are connected across two phases, the lamps being arranged so that

the current is distributed equally over the three circuits, so as to maintain the balance of the system.

Another method of combining lighting and power on a three-phase system is to run a fourth wire from the common junction, if the star connection be used. The lamps are connected between this fourth wire and any one of the three main cables, thus doing away with the necessity for balancing the three circuits.

For mining work, the multiphase system is specially adapted, and already a considerable amount of work has been done in this direction. The General Electric Company, Limited, have recently sent out, from their Manchester works, some three-phase plant for several South African mines, particulars of which may interest you.

The largest of these plants was one sent to the Vogelstruis mine:—The generating plant consists of two 150-kilowatt three-phase generators. They are belt driven, at a speed of 300 revolutions per minute, with a frequency of 30 cycles and a pressure of 950 volts.

Three triplex single-acting pumps, with plungers 6½ inches × 8 inches, coupled direct by means of single reduction gear to 35 H.P. motors. These motors run at 360 revolutions per minute. The pumps are designed to work at a crank-shaft speed of 45 revolutions per minute against a water pressure of 300 lbs. per square inch. They are of American design, and were made by the Gould Company.

Twelve triplex single-acting pumps, with plungers 4½ inches × 8 inches, of the same general design as the foregoing, coupled direct by means of single reduction gearing to 20 H.P. motors, running at 360 revolutions per minute. These smaller pumps are also designed to work at a crank-shaft speed of 45 revolutions per minute against a water pressure of 300 lbs. per square inch.

The main cable is triple concentric, each conductor having a copper area of ·118 square inches. The length of this main cable is 1,666 yards. The branch cables are also triple concentric. There is one length of 430 yards, the sectional area of each conductor being ·047 square inches, and another length of 1,300 yards, with an area of ·0314 square inches for each conductor.

The above cables are lead covered and steel armoured.

Another plant was sent to the Knight Central mine, consisting of two 100-kilowatt generators, running at 450 revolutions per minute; the voltage and periodicity being as described for the Vogelstruis mine. There are three triplex pumps 6½ inches × 8 inches, and eight pumps 4½ inches × 8 inches, coupled direct by single reduction to 35 H.P. and 20 H.P. motors respectively.

The length of the main triple concentric cable for this mine is 900 yards; each conductor having a copper area of ·145 square inches. The total length of the branch cables is 830 yards; each conductor having a copper area of 0·118 square inches.

A plant exactly similar to the Knight Central has been sent to Witwatersrand mine.

The following is a complete list of the motors supplied to the above three mines:—

All motors—30 cycles, 950 volts.

No.	H.P.	Speed per minute.	Starting device.	How connected.
7	35	360	In rotor circuit.	Geared to pumps.
3	35	360	" "	Belted to machinery.
28	20	360	" "	Geared to pumps.
1	10	870	Switched into circuit without resistance.	Belted to machinery.
6	5	870		

The generators for these three mines are all of the inductor type. At full load they give a commercial efficiency of 91 per cent., and the rise in temperature, after long continuous runs, is 25° C. The main switchboard is so arranged, that the generators can be run in parallel.

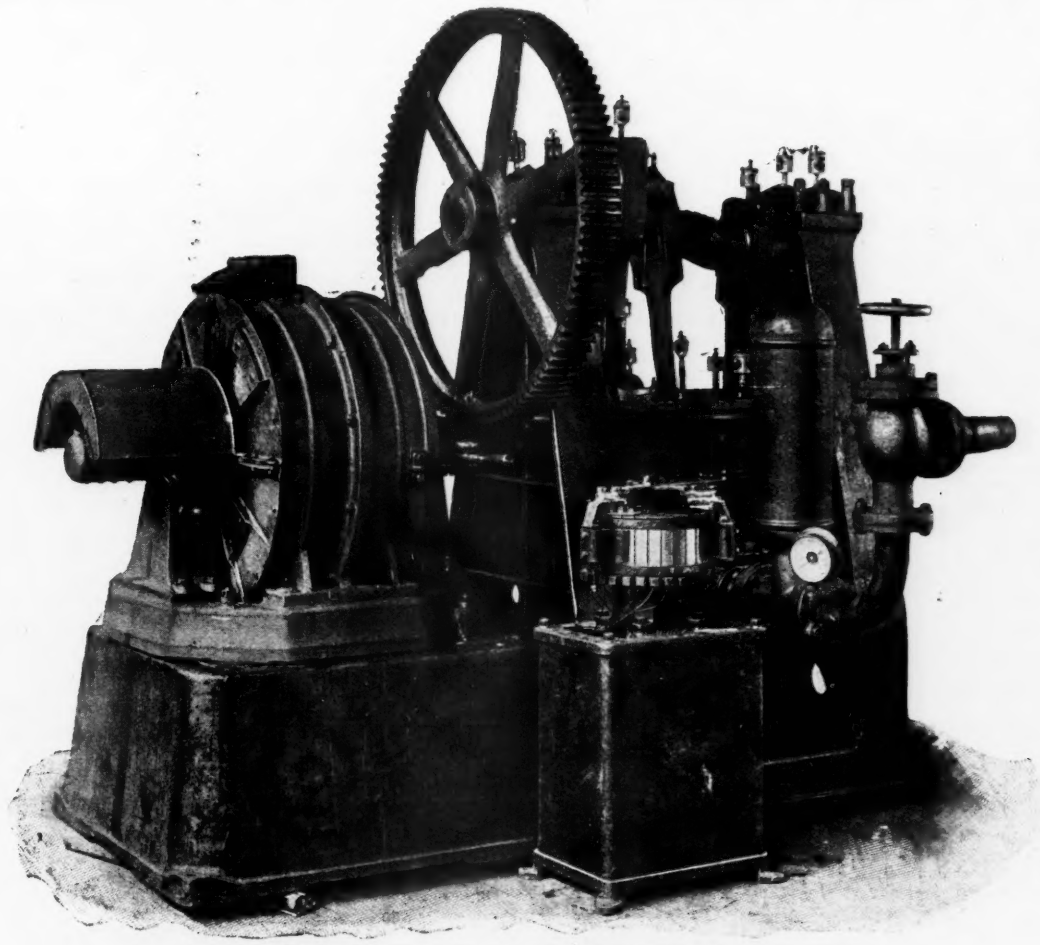


Fig. 4.—Motors of 20 H.P. with Three-Throw Pump.

As these mines are very wet, the motors were designed with water-tight and ventilated covers, as shown in fig. 4.

To enable the 20 H.P. and 35 H.P. motors to start up smoothly and gradually, they were supplied with starting resistances in the rotor. The 20 H.P. motors were made in Manchester by the General Electric Company, Limited, and each machine was coupled to its pump, and tested separately at its full load for six hours, the rise of temperature being 25° C.

The York Gold Mining Company, of South Africa, have just installed a power plant, consisting of two belt-driven 50-H.P. three-phase inductor type generators, running at 750 revolutions per minute. These supply power to two 24-H.P. motors, the motors being coupled to Easton, Anderson & Goolden belt-driven pumps. They have one 3-H.P. motor connected to a centrifugal pump, and several small motors, which are belted to various kinds of machinery, and one 9-H.P. motor coupled direct to a continuous current dynamo, the output of which is 15 volts, 800 amperes, used for cyanide work.

(To be continued.)

PHYSICAL SOCIETY.

Ordinary Meeting.

Mr. Shelford Bidwell, President, in the chair.

Mr. A. A. Campbell Swinton read a paper and showed experiments upon The Circulation of Gaseous Matter in a Crookes Tube.

The stream lines within a Crookes tube are investigated by observing the direction and speed of rotation of a mica radiometer mill mounted on a sliding rod so that it can be moved along a line at right angles to the line joining the electrodes. The axis of the mill is at right angles to both these lines. If the mill is adjusted to a position between the flat plate and the cup electrodes, with its axis just sufficiently low to prevent equal and opposite simultaneous action on the top and bottom vanes, it rotates always in the direction indicating a stream from cathode to anode. The speed is greater when the flat plate is the cathode. If, however, the mill is now moved below this line, a point is reached at which rotation ceases, and below this neutral point the rotation is suddenly reversed. Reversal is only to be observed with high degrees of exhaustion; the rotation is never so rapid here as in the first position. The mill rotates, and the reversal may be observed, whether cup or plate is made cathode, and the direction of rotation below the neutral point is always opposite to that in the position above it. A small Wimshurst machine is as effective as an induction coil in producing these effects. The experiments are intended to establish the existence, at high degrees of exhaustion, of a true anode stream, *i.e.*, a stream that travels from anode to cathode just in the same manner as the cathode stream flows from cathode to anode. This anode stream is charged positively; it is exterior to the cathode stream; its velocity is less than that of the cathode stream, but its velocity increases as the vacuum is improved. It seems probable that, at high vacua, some portion of the positive electricity passing through the tube is carried by the positively charged atoms or particles that constitute the anode stream. At lower degrees of exhaustion, the discharge passes through the tube chiefly by interchange of charges from molecule to molecule—a Grothüs chain. At the very high vacua, however, when the mean free pass is considerable, there may be to some extent a regular and complete circulation of positive and negative atoms, some of which pass from anode to cathode and *vice versâ*, and deliver up their charges, not by interchange, but by direct convection, to the electrodes of opposite sign.

Prof. Boys said he did not feel altogether convinced by the experiments that the rotation of the mill was due to simple mechanical motion of the particles of matter between the electrodes. The weight of air left in the tube at such high degrees of exhaustion was extremely small; it was difficult to realise that its impact could produce the sudden mechanical effect observed at the moment of the reversal of the rotation of the mill.

Mr. Wimshurst thought it important to keep in mind the existence of mercury-vapour in the tube. He also referred to some experiments in which a bar of metal was used to explore a focus-tube, by observation of the changes of luminosity produced in different positions.

Dr. Chree said that if the rotations of the mill could be shown to indicate a velocity of the particles of the same order as that observed in Crookes's experiments, it was safe to assume the existence of a similar cause. This might be important in deciding as to the general truth of the bombardment theory of Crookes. He asked whether the rotation had been investigated within the dark space around the cathode.

Mr. Appleyard suggested that in tracing the cause of the rotation it would lead to simpler results if the vanes of the mill were made of some light conducting substance. Mica introduced difficulties owing to its retention of the charges.

Prof. Boys pointed out that this could be done by gilding the mica.

Mr. Campbell Swinton, in reply, said that the objection raised by Prof. Boys to the mechanical theory of the rotation would apply equally to the whole theory of electro-radiometry, including the case of the mill used originally by Crookes in the direct path of the cathode-stream. But it must be remembered that although the mass of matter present within the tube was very small, its velocity was proportionately great, it was of the order of 9,000 kilometres per second; hence the contained matter might be conceived as capable of producing the observed acceleration, and Crookes's bombardment theory might with safety be adopted as a safe working hypothesis. In the tubes used for these experiments the exhaustion was carried so high, that the negative dark space appeared to fill the whole tube. He had, so far, only tried mica for the vanes; but he thought it would be important to observe the result with a substance that did not retain the charges.

Mr. A. Stansfield then read a paper on Thermo-Electric Pyrometers.

In obtaining photographic records of the readings of thermo-electric pyrometers, the range of measurement is limited by the size of the photographic plate. For long ranges of temperature, the sensitiveness of the galvanometer must therefore be small. When it is desired to examine the temperature changes in detail, as for instance at the melting points and freezing points of metals, it is necessary to employ some device for giving a more open scale for the short temperature ranges that include those particular points. For this purpose two galvanometers are arranged in parallel, and so that they have their deflections recorded on the same photographic plate. The less sensitive galvanometer covers the entire range of temperature throughout an observation; the other is brought into use for magnifying special portions of the range. In this latter case part of the electromotive force of the thermo-couple is compensated by an opposing electromotive force, applied at two points of the circuit, from a battery of Clark cells in series with a high resistance. The recording apparatus consists of a photographic plate mounted on a float, that rises steadily when water is admitted into a cylinder. The source of light is a glow lamp, enclosed in a wooden box. A brass tube, with a rectangular diaphragm at the end nearest the lamp, cuts off all light except that from a selected piece of vertical filament. Light from this filament is reflected by the plane galvanometer mirror, and is focussed upon the photographic plate by a lens in front of the galvanometer; this method was suggested by Prof. Boys. The "cold" junctions of the thermo-couple are both inserted into a hypsometer. Very serious discrepancies exist between the indications of couples having nominally the same composition; they are too great to be attributed to accidental differences in the constitution of the alloys. Although with platinum alloys, coupled with platinum, 10 per cent. of iridium gives a more powerful couple than 10 per cent. of pure rhodium, the partial substitution of iridium for rhodium very considerably lowers its thermo-electric power. This result suggests that the change in the thermo-electric power of a metal depends upon the extent to which it is saturated with the alloying metal; thus 10 per cent. either of rhodium or iridium would, *per se*, more completely saturate the platinum than would 10 per cent. of a mixture of the two metals. The author discusses a series of curves derived from his experiments. He concludes that, thermo-electrically, there may be two classes of metals (1) the ordinary metals, for which the curve representing the first differential of electromotive force with respect to temperature is a straight line, and (2) the platinum metals, together with a few such as nickel and cobalt, for which the curve of that differential, multiplied by the absolute temperature, is a straight line.

Dr. Chree discussed the curves, and asked how far stirring affected the results; he was inclined to think that stirring was a mistake.

Mr. A. Campbell inquired whether the galvanometer kept its zero sufficiently well throughout the tests.

Mr. Stansfield, in reply, said he had also come to the conclusion that stirring was a mistake; and it was a mistake to use a large quantity of metal. The pyrometers were sensitive to about a tenth of a Centigrade degree. He had experienced great difficulty with the zero of the galvanometer.

The President proposed votes of thanks to the authors, and the meeting adjourned until April 22nd.

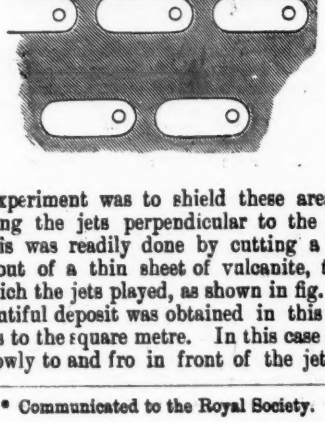
ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. GRAHAM.

(*Concluded from page* 358.)

It was thought that this might be cured by inclining all the jets towards the face of the cathode at an angle of 35°, instead of directing them perpendicularly against the face of the cathode. The result, however, instead of being an improvement, was much worse than before. This is shown in Diagram G.

G

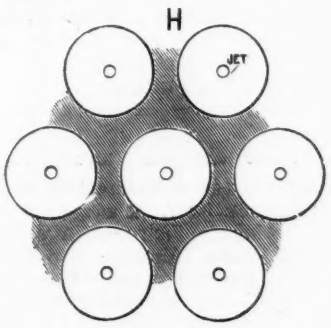


The next experiment was to shield these areas of interference, keeping the jets perpendicular to the face of the cathode. This was readily done by cutting a number of round holes out of a thin sheet of vulcanite, through the centres of which the jets played, as shown in fig. H.

A very beautiful deposit was obtained in this manner, at 3,000 amperes to the square metre. In this case the cathode was moved slowly to and fro in front of the jets to insure

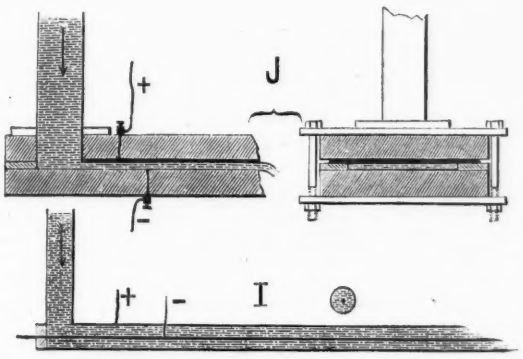
* Communicated to the Royal Society.

a uniformly thick deposit over the whole surface of the cathode.



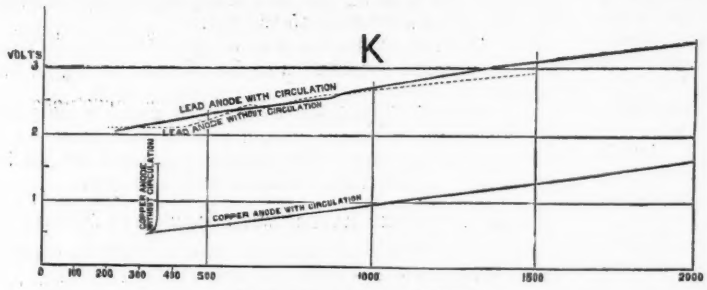
Shield with Holes.

As a very rapid circulation of the electrolyte appeared to be the principal condition of success, two new forms of apparatus were devised, which are shown diagrammatically in Diagrams I and J. The one for producing the circulation over a wire, the other for producing it over a flat surface.



Taking Diagram J, which shows the apparatus for depositing strips or sheets. The electrolyte was forced with great rapidity by means of a centrifugal pump, through the pipe, and through the space enclosed between the anode and the cathode, and thence back to the elevated tank to which the pipe is connected.

In order to ascertain the difference of potential between the anode and the cathode at various current densities both with lead and copper anodes, a number of observations were made, the results of which are shown in Diagram K.



Amperes per Square Metre.

The volts are measured vertically, and the amperes per square metre are measured horizontally. The continuous thick black line at the top shows the voltages with a lead anode, the thick red line lower down shows the voltages with a copper anode.

It will be noticed that in the form of apparatus used for these experiments, that the anode as well as the cathode was very energetically washed, and in order to further examine the effect of washing, a lead and a copper anode were tried in an ordinary tank where no circulation was taking place; all the other conditions of the experiment being as nearly as possible the same as when there was circulation.

The dotted black line at the top shows the voltages with the unwashed lead anode, showing that the washing has not much effect on a lead anode.

But with a copper anode the effect is most striking.

The current for this last experiment was in the first place taken from a single cell, through a resistance, and the curve is shown by the black line at the bottom left-hand corner of the Diagram K. It will be seen that the currents and voltages rose pretty regularly to about 300 amperes to the square metre: at this point the voltage began to rise more rapidly, and at 350 amperes the voltage began to rise rapidly, and in a few minutes rose from ·56 to 1·57, the current at the same time falling off from 350 amperes to 106.

This experiment was repeated with two cells, but the movements were so rapid that I have not attempted to plot them. The current at the commencement was 305 amperes and the volts ·44. The volts rose almost immediately to 1·42, the current falling at the same time. The volts then rose more slowly and at the end of half an hour had risen to 3·66, while the current had fallen from 305 amperes down to the insignificant amount of 30·5.

Lastly, in order to get a more extreme example of this phenomenon, the anode and cathode were coupled to the 100-volt main of the Kensington and Knightsbridge Company and the current taken through a water resistance.

A current of 122 amperes per square metre was allowed to pass and kept nearly constant. The voltage rose rapidly to 26 volts and remained pretty constant at that figure.

It should have been mentioned that the anode and cathode were well cleaned and rubbed bright with emery paper, before making each of the above experiments. The cathode was a square plate of copper having an area of 10 square inches. The anode was the same size, and they were placed about 1 inch apart in the electrolyte.

This tendency of the voltage to rise abnormally when a certain current density is reached, was not noticed with lead at all, and was not observable with washed copper anodes until about 2,000 amperes to the metre had been reached.

Some of the preceding experiments appear to point to the conclusion that so long as a path through the copper molecules can be maintained for the current, but little, if any, of the current will pass through the hydrogen molecules; the current will, in fact, follow the line of least resistance, and in order to see whether this was true of iron as well as of hydrogen, a dilute solution was prepared which contained iron and copper as sulphates in the following proportions:—

Water	100·0
Copper	·3
Iron	·1.

A current at the rate of 550 amperes per metre was passed, the electrolyte being circulated in the manner shown in Diagram J, and the deposited metal was analysed to ascertain whether any iron had been thrown down with the copper; not a trace was discovered.

This was repeated with half the amount of copper above mentioned in solution, viz.:

Water	100·0
Copper	·15
Iron	·1

The amperes being reduced to 330. Again no iron was found in the deposit.

A considerable number of experiments were also made for the purpose of ascertaining whether soda, potash, zinc, or aluminium, if present in large quantities in a solution of sulphate of copper, would alter the character of the copper deposit; so far as could be judged by the eye they made no difference, but the deposits were not analysed.

The fact that the current will pass through the copper molecules in preference to passing through the molecules of other metals, which may be in solution so long as a path through the copper molecules is maintained, appeared to offer a ready means of depositing copper in an almost pure state from the very impure solutions which are obtained by lixiviating certain ores.

The Rio Tinto Company in Spain produce very large

quantities of such solutions, and they were good enough to send the author samples of some of their solutions. The strongest of these solutions was analysed by Mr. Swinburne and found to contain the following metals which were all assumed to be present in the form of sulphates.

Copper	11·09	Grammes per litre of the solution.
Iron	17·31	
Cadmium	0·22	
Aluminium	0·63	
Zinc	2·29	
Magnesium	0·24	

The solution, it will be observed, contained only about 1 per cent. of copper. From this solution the copper was thrown down without any difficulty in the form of both wires and sheets by the apparatus shown in Diagrams I and J. The current for the wires was about 550 amperes to the metre, and no difficulty was experienced in drawing the wire so deposited, nor did the wire show any signs of brittleness.

The current for the sheets was considerably denser than in the case of the wires, a perfectly good deposit being formed.

The author is also much indebted to the Tharsis Company who kindly sent him samples of the impure solutions of copper prepared by them from ores which they treat.

One of these samples was analysed by Mr. Swinburne, and found to contain the following metals, which were believed to be present in the form of chlorides.

Copper	32·54	per litre of solution.
Iron...	7·42	

Aluminium, Zinc, Potassium, Sodium } not determined.

Although here, as with the Rio Tinto solutions, no difficulty was experienced in depositing the copper, yet it was found to be impossible to get a deposit of a good colour at any current density however small. The deposit instead of being a pale salmon colour as desired, was invariably of a dirty brown colour, and for some time this was supposed to be due to the presence of some other metal, but it was found that copper thrown down from a solution of pure chloride of copper was of the same dirty colour, and that the addition of sulphuric acid in very considerable quantities to a solution of chloride of copper made very little difference in the appearance of the deposited metal.

The discolouration, therefore, appeared to be due to the presence of chlorine, and to determine this point a saturated solution of sulphate of copper was taken, and to it was added commercial hydrochloric acid in the proportion of two cubic centimetres of hydrochloric acid to one litre of the copper solution. This amount of hydrochloric acid made hardly any perceptible difference in the appearance of the deposit. With three cubic centimetres a change became noticeable, and with six cubic centimetres of hydrochloric acid to one litre of saturated sulphate of copper, the deposit was about as dark in colour as if the whole of the copper had been present in the form of a chloride. In these experiments the current was at the rate of 1,000 amperes to the metre.

It, therefore, appeared that to treat the Tharsis solution effectively, it would be necessary to convert the copper into a sulphate and to get rid of the chlorine. This was economically effected in the following manner: soda or lime were added in quantities just sufficient to throw down the whole of the iron as a hydrated oxide, leaving all the copper chloride in solution. After the iron precipitate had been separated out, a further quantity of soda or lime was added to the clear solution, and the whole of the copper was thus thrown down as a hydrated oxide: this oxide of copper was then very thoroughly washed and dissolved by sulphuric acid, and from the solution so obtained the copper was easily thrown down as a perfect deposit.

One advantage of this method of working is that the dilute solution of chloride is converted into a saturated solution of sulphate.

The author is much indebted to Mr. Crompton, who very kindly allowed him to use his laboratory at Thriplands during all the earlier experiments mentioned in this paper.

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

IV.

The Atmospheric Electrical Potential.

Although Exner's determinations alone, absolutely prove, and with sufficient exactitude, the measure of the increase of potential at a strikingly high rate in proportion as the distance from the earth increases; this fact of immense and still unrealised importance, had already been discovered by Sassure and by Volta of immortal memory over a century ago.

Gay Lussac's Aerostatic Determinations.

The aerostatic experiments of the great chemist, Gay Lussac, in 1805 corroborated Volta's discovery.

Gay Lussac's temperature and other results have been plotted on the diagram, fig. 12, along with Exner's electrical

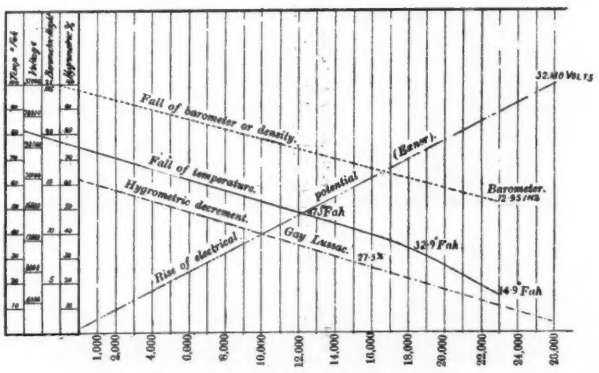


Fig. 12.—Distance from Earth in Feet.

Graphic diagram, showing the remarkable correlative evidence of the fall o the barometer, or density of the atmosphere, the reduction of aqueous vapour and the temperature, and the rise of the electrical potential—with the increase of distance from the earth.

determinations. It will be noticed that at the height of 23,040 feet above the level of the sea the temperature had fallen from 82° F., the temperature at the earth's surface to 14·9° at the altitude defined.

Gay Lussac found that the density of the atmosphere decreased at a height of 22,912 feet to less than half its value at the surface of the earth—the barometer had sunk to 12·95 inches.

The hygrometric researches proved that the aqueous vapour proportion fell from 62 per cent. at the earth down to 27·5 per cent. at an altitude of 15,190 feet.

He (Gay Lussac) also found at an altitude of 23,000 feet that the chemical constitution of the air had undergone no change.

If the writer's hypothesis is correct, it would mean that the fall of the barometer should proceed *pari passu* with the fall of temperature. The diagram shows that the fall is parallel, and is, therefore, consistent with the theory.

The Fall of Temperature with Increased Altitude.

The fall of temperature in Gay Lussac's aerostatic experiments is as follows:—

Temperature at the earth		= 82°	Fahr.
,,	at a height of 12,125 feet	= 47·3°	,,
,,	,, ,, 18,636 ,,	= 32·9°	,,
,,	,, ,, 23,040 ,,	= 14·9°	,,

In the verbal demonstration of the solar electrical hypothesis it is, perhaps, unnecessary to say that the expression vacuum is merely employed to explain an imaginary condition of the extreme tenuity of the atmosphere, that will permit the transmission of high potential currents with a minimum of loss. It is well known that, in proportion as the atmospheric tenuity is increased (within certain not as yet well-defined limits), is the electrical resistance reduced; this can be proved by con-

necting the terminals of an electric collector machine with a so-called vacuum tube; it will be found that a far longer discharge can be obtained than if the terminals are divided by an atmospheric interspace of normal density. It is, however, not absolutely essential to assume such a rarefaction in order to obtain a miniature resemblance of solar electrical effect.

A Laboratory Demonstration.

Fig. 13 is a diagram intended to represent the remarkable luminous effect on two terminal spheres of a Voss machine, the experiment can be repeated by anyone.

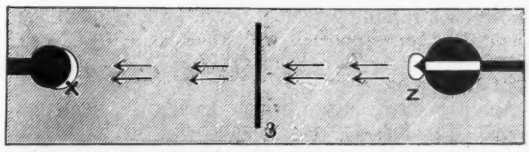


Fig. 13.—Voss Electrical Collector or Machine.

Diagram showing the luminous surfaces on two spheres, x and z, by the emission and reception of electrical energy of high potential.
An opaque diaphragm 3 can be placed so as to intercept any possible reflection, but the luminous effect is not reduced. The human hand placed in the position of the diaphragm will realise a sensible reduction of temperature, but will not be influenced by the flow through it of the electrical energy.

The high potential (brush discharge) current across an air interspace produces at the projection from the discharge sphere a luminous effect, which is repeated on the reception surface of another and *vis-à-vis* sphere. To prove that the second luminous surface is not merely the effect of reflection from the *vis-à-vis* luminous surface, one has only to place an opaque board so as to intervene between the two spheres, as shown on the diagram, there will still be the same dual luminous evidence. If the opaque board is replaced by the human hand a sensible cooling influence will be evident, but no electrical effect will be produced and the energy flow will not be appreciably affected. Both at and around the projection of the negative sphere terminal, which can be considered to represent the solar sphere, and at the surface of reception of the positive sphere terminal representing the earth, there will be noticed in the dark a luminous area, relatively great in proportion to the surface of the sphere; if a pointed projection was provided for the positive sphere and on the opposite side to the luminous surface, the electrical energy would be dissipated into the atmosphere by which it would be again collected by the Voss machine or other electrical collector, of which the solar sphere is an example. Now referring to diagram *a* of the positive sphere terminal, *x* is moved in a circular line around the negative sphere *z*, the electrical energy will follow this movement and take the direction of a radial line drawn across the centres of two spheres.

The only difference between the electrical solar hypothesis and this laboratory proof, is the fact that in the latter the interspace is of atmospheric density, but even then there is practically no luminosity in the interspace except in or about the surfaces of emission and reception of the electrical energy.

It may be suggested from the proof adduced, that in order to produce the luminous effects at the surfaces of emission and reception, it is not necessary that the solar and terrestrial luminosity is produced by the increased resistance of their respective atmospheres to the flow of electric energy. This is granted, but in order to satisfy the conditions enforced by the law of the conservation of energy, it is necessary to assume such a high rarefaction or reduced density between the sun and the planets as will permit the unimpeded flow of electrical energy, and we know, as a positive fact, *that the density of the atmosphere* does decrease in a now well-defined proportion to the distance from the earth's surface.

The Movement of the Planetary Bodies.

The hypothesis that the entire celestial or interplanetary and interstellar space is really an accumulator reservoir, or ocean of low pressure electrical energy, that will permit, as does the earth's atmosphere (which constitutes part of this electrical ocean), the flow through it of high intensity electrical currents, permits the application of the magnetic attraction theory to displace and fulfil the conditions of the Newtonian gravity hypothesis.

The author suggests that the rotation of the planets may be effected somewhat in the same way that an electric motor is rotated, and their high and generally compound rotation may give them their distinctive orbits. No doubt it could be demonstrated that a rotation could be given to a spherical body, which would propel it in a certain specific direction, and if the orbits of the planets were mathematically circular, this hypothesis would apply; but the fact that the orbits of the interplanetary and interstellar bodies do not generally assume this form, inclines one to the opinion that the orbit is the result of the attractive influence of the great central solar electrical body, and that the spherical rotation is the result of the electrical energy rotating the polarised planets in some way, as a current rotates an armature.

As far as the moon is concerned, it is suggested that the electrical attraction of the earth, added to the rotating influences set up by the solar electrical centre, may be some explanation of its peculiar orbit, surbordinate to the planet earth.

Saturn and its Rings.

The movement of the rings of the planet Saturn, in their particular and regular plane of inclination, may constitute the source of motion of this planet, assisted, as it would be, by the rotation of the planet itself.

The constitution of the rings is not yet adequately defined; the rings may be associated with an atmospheric annulus, by which the associated rings are illuminated.

The Cometary Orbit.

The cometary orbit will also be produced, it is suggested, in a somewhat similar way to that of the planetary bodies, but their particular form is apparently influenced by the contiguity of other planetary electrical conductors.

The strange feature of the cometary orbit, is the sudden reversal of the direction of cometary movement at the aphelion.

Law of Compensation of Electrical Energy.

It may be rightly argued that as the electrical energy is absorbed in generating luminous and thermal effects, and incidentally in maintaining innumerable other forms of energy that there will be a constant loss of the energy projected from the solar electrical supply stations.

There is the great absorption of energy in internal—or interterrestrial—electro fusion work which is always going on, as we know by the occurrence of volcanic eruptions, by the increase of temperature in deep borings, and by the contraction of the earth's skin. But it may here be remarked that although we may, by electrical resistance effects, raise metals to a state of fusion, if this action is performed in a *reducing atmosphere*, it doesn't necessarily imply that the metal is being burnt up or in any way altered; and, further, under such conditions the additional electrical energy that will be required to maintain the metal in a state of fusion is only that required to compensate for the loss of the heat that flows to that part of the surface of the earth, that is, in its rotation, removed from the direct influence of the sun's supply of electrical energy.

It is, therefore possible, that when the electrical energy was initially introduced to the conductor planetary body, there would then be an immense absorption of electrical energy in effecting internal fusion work, and at this time all the igneous effects noticed in the shell of the earth and producing contraction of the bulk of the sphere would be then effected. However, this is an aside from the subject of the article.

Becquerel (one of the very many illustrious *savants* by which France has enriched the world) suggested that the atmospheric electricity was the product of chemical changes always preceding and induced by chemical action. Here, therefore, have we the basis of the law of compensation of electrical and solar energy.

The proportion of solar electrical energy absorbed in stimulating chemical action will by electrolytic, electrothermal, and other changes occurring both on the surface and in the interior of the earth, be exactly returned to the low pressure electric interplanetary ocean, and this great accumulation of energy will renew the solar centre in proportion to its supply of energy to planetary and other bodies in the celestial space.

THE ATMOSPHERES OF JUPITER, MARS, AND VENUS.

The surface of Jupiter is enclosed in varied masses of flocculent cloud form. This planet has a highly reflective surface—so much so that the effect of its luminous atmosphere is incidentally reflected, and with a loss of 23 per cent. of the initial energy, so that the absorption by this planet of solar electrical energy is very slow.

Herschel identified the dark belts of the atmosphere of Mars as tracks of comparatively clear sky.

These dark belts, it is suggested, are composed of an atmosphere of extremely low density, offering little, if any, resistance to the flow of the high intensity electrical energy emitted from the orb of solar electrical supply.

An alternative explanation is that the dark belts cover the surface of emission from this planet of low intensity electricity and the light or luminous belts constitute the atmospheric surfaces of introduction to the planet Mars of the high intensity electrical currents.

Luminous atmospheric effects are conspicuous in Venus.

When this planet is at inferior conjunction or below the sun, its entire disc periphery is not uncommonly rimmed with a glorious halo of luminous rays, bent inwards, as if by the action of lens.

(*To be continued.*)

ALUMINUM AS A RIVAL OF COPPER AND BRASS FOR ELECTRICAL CONDUCTORS.*

By ALFRED E. HUNT, S.B., President of the Pittsburg Reduction Company.

(*Concluded from page* 321.)

THE power of withstanding corrosion is greatly in favour of aluminum as an electrical conductor over copper. Copper does not change in dry air, but in moist air it becomes covered with a green layer of basic carbonate of copper, which, itself, has a corroding action, and does not coat and protect the underlying copper from further corrosion. Ammonia, in contact with copper, absorbs oxygen and the copper dissolved, in consequence of the formation of a soluble cupric-oxide and ammonia. This action is especially a source of trouble where copper wire is used in connecting rail joints in the tracks of electrical railroads, where the ground is often subject to ammoniacal solutions.

Aluminum, similarly, is not acted upon in dry air, and the corrosion in moist air is of the oxide of aluminum, alumina, a harmless salt, which forms an impenetrable coating on the metal, and protects it from further corrosion to a considerable extent. Ammonia solutions act on aluminum only upon the surface, attacking it, and leaving behind a more resisting surface coating of a brown colour containing silicon, which resists corrosion from dilute mineral acids and dilute solutions of organic acids, as well as moist and dry air. Subject to sulphur gases, such as locomotive flue gases, aluminum withstands corrosion better than copper.

If kept free from galvanic action with any other metals electro-negative to itself, aluminum is far less easily corroded than copper.

The difficulty of soldering or brazing aluminum is the chief drawback to its use as an electrical conductor. Aluminum can be soldered strongly, but it is a more difficult and slow operation at best as compared with copper, and there is much more rapid weakening of the soldered joint due to galvanic action between aluminum and the metals of the solder than with the less electro-positive metal, copper.

In many places the aluminum can be first coated with copper, and the soldering or brazing operation made on the copper surfaces thus formed.

Several forms of joints have been successfully used to avoid the necessity of soldering, the best forms being to use thin aluminum sheets to wrap the joints, and to twist or otherwise bind with the aluminum bars or wires to be joined. These wrapped and twisted joints with aluminum sheets can be left smooth on the outside when desired, can be made much stronger than the body of the conductors, and are really a more serviceable job than soldered or brazed work in many cases with copper. One very practical way of making joints of aluminum wire is to roll the thin aluminum sheet, of about 6 inches width, into two cylinders from opposite edges of the sheet. These double cylinders are very cheaply made on mandrels in a lathe. The ends of the wires to be joined are inserted in these cylinders from opposite ends, and both the wire and sheet twisted with pliers until a firm joint is secured, much stronger than the body of the wire. The joint can readily be made impervious to the air and moisture.

The C. McIntire Co., of Newark, N.J., have a patented joint which is made very much along the lines of this joint. Information regarding their patented form of joint can be obtained by correspondence with them as above. Also the American Electric Fuse Company, Chicago, Ill., make a very satisfactory joint.

Another disadvantage which handicaps aluminum in special uses for electrical conductors will be where the material has to be insulated, that the cost of insulation will be approximately one-third greater for the larger section required in aluminum over the cost for the smaller section of copper required for the given conductors; and where aluminum is to economically compete for insulated conductors the price of the aluminum will have to be further reduced to meet this contingency.

Aluminum is soon to be placed in an extensive line of conductors where this added extra cost of insulation will be determined by actual fabrication. The Pittsburg Reduction Company in this particular case agreeing to pay the added costs, in order that actual experience may be gained as to their relative amounts.

There are certain places where aluminum will be at a disadvantage over the smaller section of equal conductivity of copper, in ducts or conduits where space is a considerable item. In such cases, the use of aluminum would necessarily be prevented.

An ample field for the employment of aluminum for some time to come, however, seems open at the present time for bare transmission lines, especially for high potential long distance work and for long distance telephone lines, and for rapid transmission telegraph lines.

Aluminum, next to gold, is the most malleable of all the metals, and is much more malleable than copper.

Aluminum in ductility stands next to copper, and is easily drawn into all sections that are furnished in copper for electrical conductors.

Aluminum can be furnished fully as uniform in its composition as copper.

The metallurgy of copper is comparatively complicated, owing to the difficulty of converting its ores into the oxide free from impurities. In most of the copper ores used, sulphur, lead, and iron are contained, as well as small quantities of other elements, as arsenic and antimony. All of these elements in metallic copper very materially lower its electrical conductivity. The native pure copper of the Lake Superior region enjoys the preference, due to its uniformity and freedom from impurities, for many purposes, but for electrical conductors the electrolytic copper is most used.

Aluminum can now be furnished rivalling, for electrical conductors, at least 99·50 pure, it is granted not as yet, in purity of composition the best electrolytic copper used for the purpose of electrical conductors. When a fused metal is obtainable, undoubtedly it will more nearly rival copper for electrical conductors section for section.

Aluminum has been already in successful operation as an electrical conductor for some time. The first use in a large way was with the conductors for the electric current at the at the Niagara Falls works of the Pittsburg Reduction Company, where it has been used since the year 1895. The currents were of several thousand horse-power each and of very large volume and comparatively low voltage. Both in conducting power, freedom from heating effects, power of withstanding corrosion, ease of making, wear, and efficiency of joints, the aluminum conductors have given better results than copper used for the same purpose.

In the Chicago Stock Yards, a mile of aluminum wire of No. 11 gauge has now been in use for some time upon a telephone line that has been badly corroded out in copper wire, due to its being frequently subjected to sulphur gases from passing locomotives. The aluminum line is giving

* Advance proofs of this paper were courteously forwarded through the Secretary of the Institution of Electrical Engineers.

good satisfaction, and is withstanding corrosion much better than did the original copper wire subjected to the same influence.

If the theory be true that the passage of high voltage alternating currents of great frequency is largely upon or near the surface of the conductors only or mainly, then the larger section of the proposed aluminum conductors will make them especially adaptable for such currents.

On telephone lines it has already been determined that as good sound transmission is obtained with aluminum of equal section as with copper, in ordinary lengths of less than 10 miles of wire. No comparative results, however, have as yet been determined on long distance telephone transmission; but the evidence would seem to point that a much less section than 160 of aluminum to 100 of copper will give equally good results.

Aluminum is now being used to replace brass very considerably in the arts, as it is sold in the open market at rates which make it 10 per cent. cheaper, section for section, than brass.

For electrical purposes, the metal can be advantageously used to replace brass in a good many ways. Commercially pure aluminum as furnished to-day contains less iron than does commercial brass, and is, therefore, more non-magnetic than brass.

The electrical conductivity of aluminum is far superior, section for section, to brass. Almost every electrical apparatus of present construction in which an iron core—usually a laminated iron core—is used, in motors, generators, or transforming machinery, has spaces for ventilation, and the spacing is made by the means of drawn bars, flat rods or angles or tee-shape pieces. Brass has been almost invariably used for this purpose in the past—probably on account of its non-magnetic properties as compared with iron or steel. Drawn aluminum sections can be furnished at a price which is 10 per cent. cheaper than brass, section for section; and on account of the lightness of aluminum, it can be advantageously used.

Where a low electrical conductivity is desirable, as in parts that are moved in a magnetic field, to prevent the occurrence of eddy currents, aluminum can be alloyed with zinc and other metals that will lower its electrical conductivity to the desired point.

ERECTION OF OVERHEAD TROLLEY LINES.

By GEORGE C. SILLAR.

When erecting overhead trolley wires for electric tramways, care must be taken to allow sufficient dip in the wire to provide for the maximum reduction of temperature during the winter season, and so avoid overstraining of the wire.

To enable this to be determined readily, the accompanying diagram may be of assistance in saving time in calculations.

In plotting the diagram the following have been assumed:—

1. That the tensile strain of trolley wire is equal to 25 tons per square inch.

2. That the safe working strain is one-fourth the tensile strain.

3. That the elongation of the wire is 0·0018 times between the freezing and boiling points of water, or 0·0001 times for each 10° F. rise.

4. That the dip of a wire varies as the square of the span, which is not theoretically correct, but for all practical purposes it is so within the limits of span and dip met with in trolley wire erection.

It will also be recognised that for a given span, and with a given strain per square inch of section of wire, the dip will be the same for all sections of the same material.

Referring to the diagram, the curve on the upper part gives the rate of increase of dip for a copper wire, having been determined experimentally, as follows:—

The wire experimented upon was fixed firmly at one end while the other was passed over a pulley exactly 100 feet distant.

The wire was then loaded at the pulley end with a weight equal to one-fourth its tensile strain.

The dip under these conditions was then measured and taken to represent the minimum dip at 0° F., after which the length of wire between the points of support was increased by an amount equal to a rise of temperature of 10° F., and the dip again noted, which latter proceeding was repeated a sufficient number of times to allow for a range from

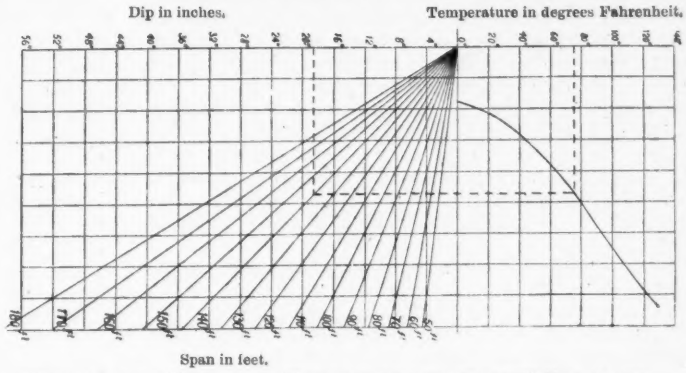


Diagram giving Dips for any Temperature from 0° to 130° Fah. at any Span from 50 Feet to 180 Feet.

zero F. to 130° F., these being assumed to be the minimum and maximum temperatures to be provided for in this country.

On the lower part of the diagram, diagonal lines are drawn representing the spans, and are arranged so that the distance between them on any vertical line varies as the square of span which they represent, consequently the dip for any one span being known the dip for any other span can be read off without trouble.

It will be obvious how the top and bottom sections of the diagram are intended to be used, but to take a concrete case assume that it is required to determine the safe minimum dip for a span of 140 feet at a temperature of 75°.

Starting from 75° on the temperature column, carry the eye horizontally till it meets the curve, from which point drop a vertical line to meet the diagonal line representing the given span of 140 feet.

Opposite this point on the left hand column will be read the dip in inches or 18·4 inches.

This sequence of operations is indicated by the dotted line.

THE UTILISATION OF MAGNETIC ACTIONS FOR THE DIRECT TRANSFORMATION OF HEAT INTO MECHANICAL WORK.

In a note presented to the Académie des Sciences on October 11th, and reproduced in full in *L'Industrie Electrique* for October 25th, 1897, No. 140, p. 456, M. Marcel Deprez, after many other writers, called attention to the possibility of transforming thermic energy into work by utilising the variations of the magnetic constants with the temperature and the remarkable magnetic properties of the alloys of iron and nickel recently discovered by our *collaborateur*, Ch. Ed. Guillaume.

M. Marcel Deprez's note* concluded with this seductive promise:—

"In a future paper I shall show how the same principle enables us to transform heat directly into mechanical work, and I shall describe the conditions under which these two kinds of apparatus, the thermo-magnetic motor and generator, would be capable of giving really practical and economical results."

We have looked in vain since in *Comptes Rendus* for the promised communication, but in the *Revue Générale des Sciences* of January 30th, 1898, we find an article by M. Marcel Deprez which supplies its place, and seems to imply that the thermo-magnetic motor and generator capable of giving really practical and economical results have yet to be realised, for the writer begins with the following declaration:—

* See Electrical Review, February 18th.

"A profound study of the question has led me to the conclusion that if these results are ever obtained, great difficulties will have to be overcome," and the object of the article is to show the nature of these difficulties.

The principle of the thermo-magnetic motor, to which M. Marcel Deprez applies the ferro-nickel alloy, consists in arranging a rod of this alloy in a magnetic field, and in making it revolve on an axis perpendicular to the direction of the field, and to this rod. It is rendered alternately magnetic or non-magnetic by cooling it and heating it in succession between the limits of temperature, at which the magnetic properties appear or disappear completely. For each revolution of the rod of ferro-nickel, two successive coolings and heatings must be produced, and the mechanical cycle will consist of four quarters of a revolution, two of which are motive, and are separated by two others that are non-motive, an action similar to that of a single-action engine with two cylinders, the cranks of which are fixed at 180°.

A first calculation shows the writer that by using a moderate magnetic field, of an intensity of 1,000 gauss, and a variation of temperature of 50° C., a variation for which the ferro-nickel is supposed to be magnetised or demagnetised completely, the efficiency would not exceed $\frac{1}{2000}$. In order to produce a quantity of mechanical work equal to 1 H.P.-hour (270,000 kgm., or 557 calories kg-d.), we should have to furnish 1,270,000 calories, representing the equivalent of 150 kg. of coal.

To give an idea of the dimensions to be given to the apparatus intended to revolve between limits of temperature not exceeding 50° C., the writer mentions the fact that in the furnaces of locomotives the heating surfaces do not, at the most, give off more than 200,000 calories per square metre per hour.

The second part of the article is devoted to showing how these conditions may be improved by increasing the intensity of the magnetic field and bringing it to 10,000 gauss, by employing a special mode of heating and cooling and by making the body which serves as a vehicle for the heat pass successively over a series of rods composed of alloys varying in the proportions of their composition and in their magnetic properties.

By using hypothesis after hypothesis, and assuming as extremely probable that the principle of Carnot is applicable to thermo-magnetic phenomena, M. Marcel Deprez arrives at finding—but not at demonstrating—that the efficiency might rise to 3 per cent, *i.e.*, to that of a steam engine of moderate power consuming about 3 kg. of coal per H.P.-hour.

Unfortunately, M. Marcel Deprez assumes the organic efficiency of the apparatus to be equal to one, which is excessive for one so heavy, bulky, and cumbersome as that of which he describes the principle; moreover, the rapid cooling and heating of the thermo-magnets must be obtained by the *mechanical* and alternating circulation of a liquid, which circulation, it seems, must absorb a power which is greater than that developed by the thermo-magnetic motor, and which is not taken into account at all.

The thermo-magnetic motor of M. Marcel Deprez seems, therefore, destined to be consigned to oblivion like the famous pyro-magnetic generator which Edison presented so triumphantly in 1888 to the American Association for the Advancement of Science.

In not presenting his second note to the Académie des Sciences, M. Marcel Deprez has shown his discretion, but we feel it our duty not to leave our readers too long in the expectation of a "thermo-magnetic motor and generator capable of giving really practical and economical results." They know now the opinion of the writer, an opinion based on "a profound study of the question."—E. H. (*L'Industrie Electrique*).

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

6,179. "Improvements in secondary batteries." O. Hamilton. Dated March 14th.

6,182. "A new medical electrical device." A. L. Burgess. Dated March 14th.

6,184. "Improved electric light for use as a search or signal light, for photographic and other purposes." E. M. Brown. Dated March 14th.

6,223. "Improvements in electric railways." C. M. White. (B. C. Seaton, United States.) Dated March 14th. (*Complete.*)

6,235. "Improvements in electrical insulators and method of making the same." J. W. Boch. Dated March 14th. (*Complete.*)

6,270. "Improved electrical lampholder." F. W. Heaton and H. Smith. Dated March 15th.

6,328. "A new and improved method of and apparatus for generating electricity." C. O'D. Barrows and C. H. Smith. Dated March 15th.

6,350. "Improvements in or connected with the manufacture of carbons for electric arc lamps." J. J. Waddington. Dated March 15th.

6,357. "Improvements in or in connection with electric motors for cars or other vehicles and in brakes therefor." W. P. Thompson. (T. von Zweigbergk, United States.) Dated March 15th. (*Complete.*)

6,360. "Improvements in or relating to electric light carbons." J. W. Strauss, J. G. Chapman, and H. Foster. Dated March 15th.

6,362. "Improvements in electric switches." T. Gillies and E. Hornidge. Dated March 15th.

6,371. "Improvements relating to the driving of sewing machines by electricity." H. Lea. Dated March 15th.

6,414. "Improvements in or relating to electric plug and ordinary switches." T. Topping. Dated March 16th.

6,451. "Improvements in apparatus for electroplating pins and other small objects." J. S. Mosrison. Dated March 16th.

6,478. "Improvements in electrical connections for lamp-holders and other electrical appliances." R. F. Hall. Dated March 17th.

6,482. "Improvements in electric light advertising." E. Lightheart. Dated March 17th.

6,498. "An improved arrangement for forming or mounting the armatures of field magnets of small electro-motors." F. A. Darton and F. G. Phillips. Dated March 17th.

6,525. "Improvements in apparatus for electrolytic purposes." W. G. Luxton and The United Alkali Company, Ltd. Dated March 17th.

6,526. "Improvements in apparatus for electrolytic purposes." W. G. Luxton and The United Alkali Company, Ltd. Dated March 17th.

6,535. "Improvements in propelling barges and boats on canals and other water-ways by electricity." W. E. Kenway and T. V. Hughes. Dated March 17th.

6,559. "Improvements in electric arc lamps." G. C. Fricker. Dated March 17th.

6,605. "Improvements in telephonic inter-communication system." W. Aitken. Dated March 18th.

6,607. "A new or improved separator for the plates or electrodes of secondary batteries or accumulators." E. J. Clark. Dated March 18th.

6,619. "Improvements in microphones." L. M. Ericsson. Dated March 18th. (*Complete.*)

6,633. "An electrical charge conductor." F. W. Cooke and T. Ireland. Dated March 18th.

6,637. "Improvements relating to the electrolytic production of metallic alloys and to apparatus therefor." C. E. Acker. Dated March 18th. (*Complete.*)

6,649. "Improvements in dynamo-electric generators and motors." C. W. Atkinson and W. H. Johnson. Dated March 18th.

6,672. "An improved receiver for electro-magnetic waves." A. F. Eves. Dated March 19th.

6,695. "Improvements in electrical regulating apparatus." R. E. B. Crompton and S. W. Ashley. Dated March 19th.

6,704. "Improvements in switchboards for the control of high voltage electric circuits and apparatus." H. F. Parshall. Dated March 19th. (*Complete.*)

6,712. "Improvement in insulators." L. F. Rembe. Dated March 19th.

6,714. "Improvements in electric switches." E. M. French. Dated March 19th.

6,720. "Improvements in depressible rail systems for electrical railways." W. Grunow, Jun., and Z. Goodsell. Dated March 19th.

6,758. "Improvements in electric furnaces." A. M. G. Sebillot. Dated March 19th.

6,762. "Improvements in the means of and apparatus for transmitting pictures and the like by electric currents." W. E. Simpson. Dated March 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9*d.* (*in stamps*).]

17,583. "Improvements for electric condensers." C. S. Bradley. Dated September 4th, 1897. This relates to electric condensers, the object being to increase the safety of the condenser, wider dielectric strain of the abnormal voltage, increase its life, to preserve a uniform capacity, and reduce its heating extent. To accomplish these aims, there is an electric condenser having its condensing plates and dielectric enclosed air-tight in a metallic casing, hermetically sealed at the joints to exclude the moisture of the air and preserve the condenser's capacity unaltered. The plates are held by stiff side-plates and are kept under pressure in an air-tight casing by a strong metallic frame, which projects beyond the edge of the casing and has a large heat radiating surface. 4 claims.